WATER WORKS & SEWERAGE

HBP ABC

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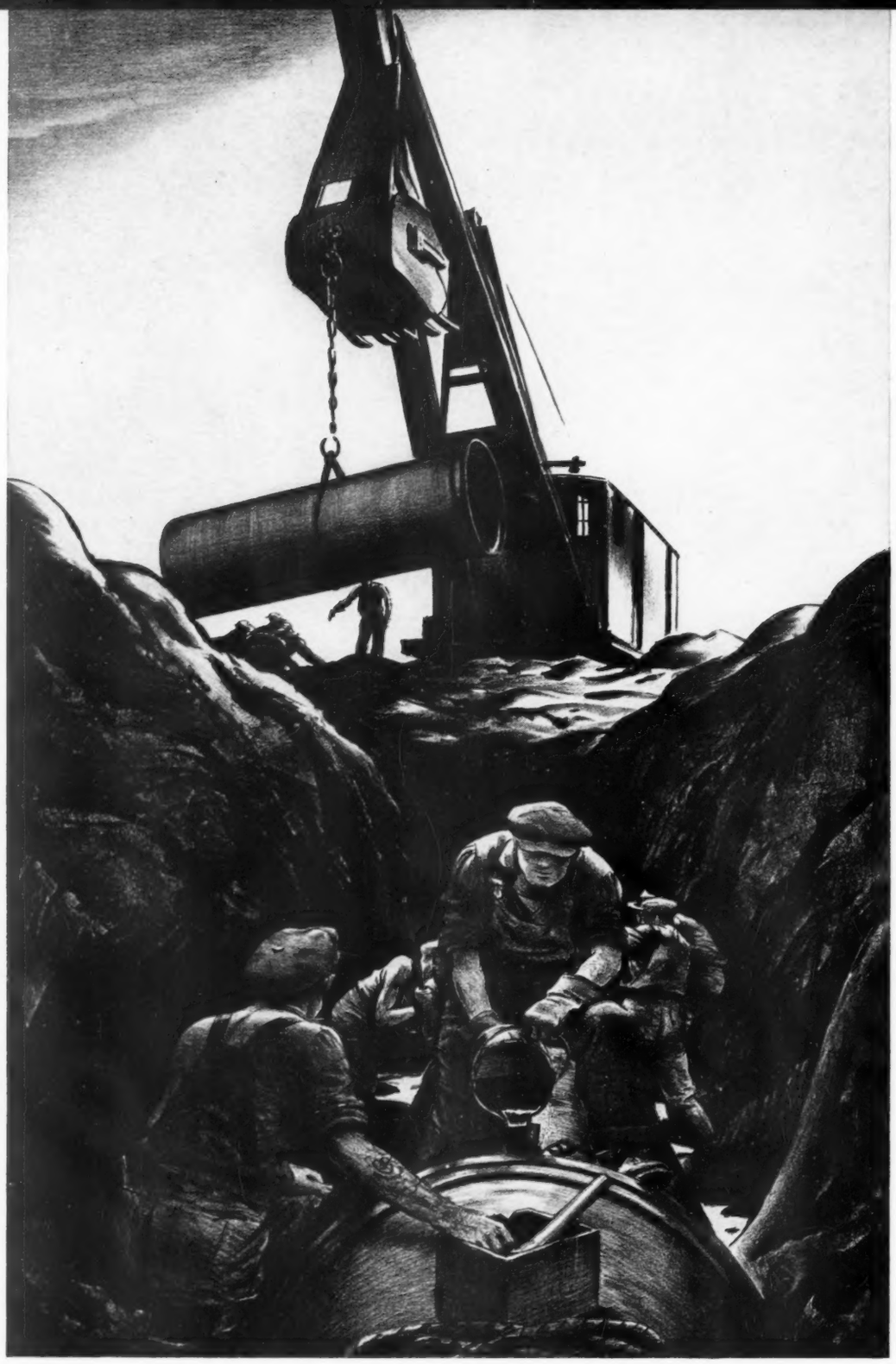

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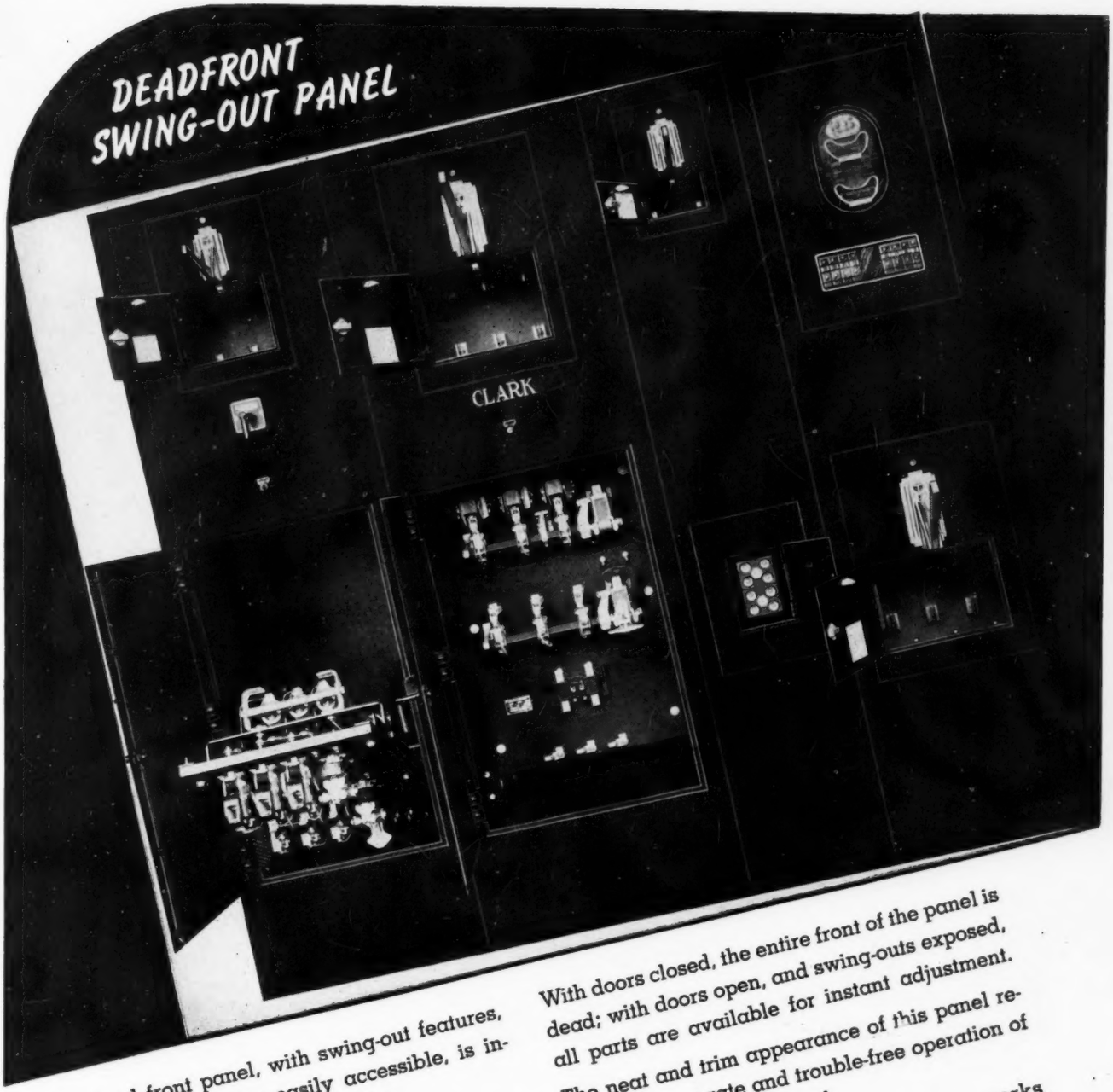

This dead front panel, with swing-out features, making all apparatus easily accessible, is installed in an Eastern Water Works.

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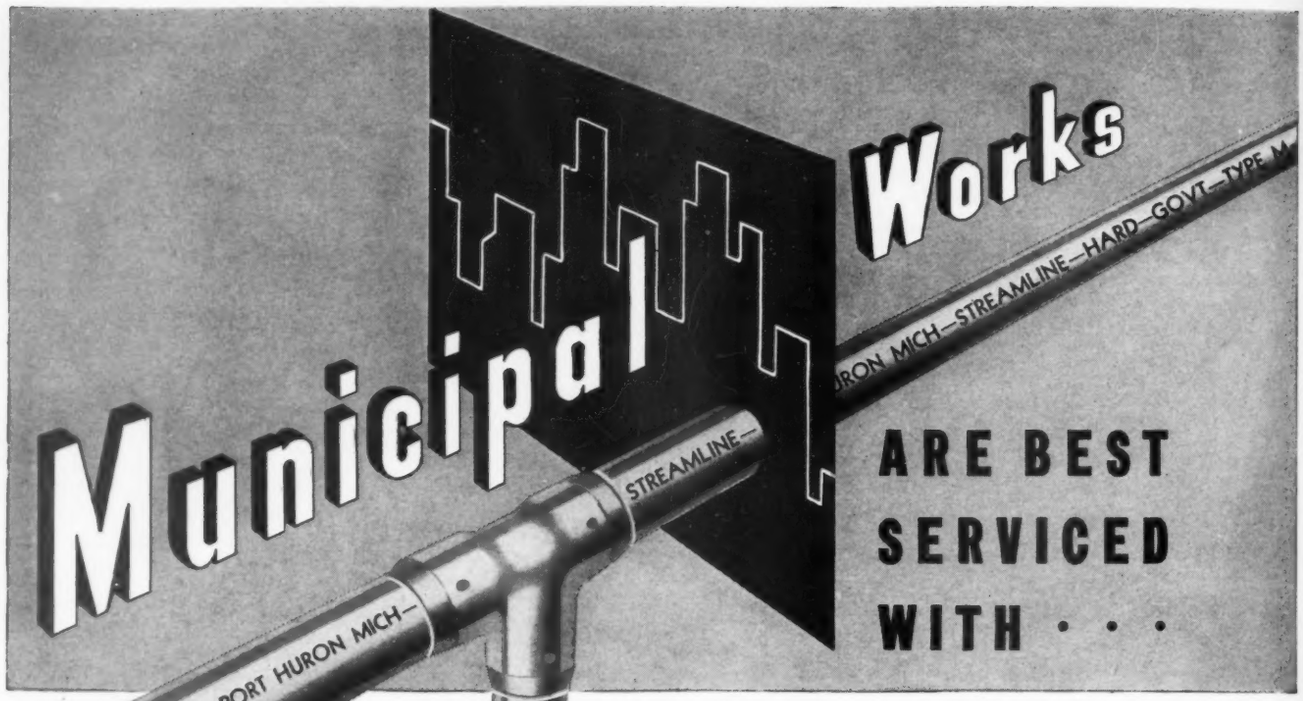

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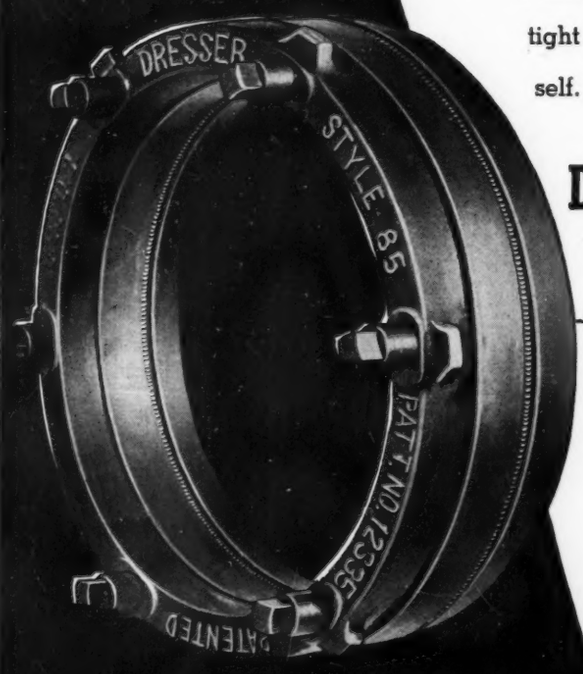

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Compiled by
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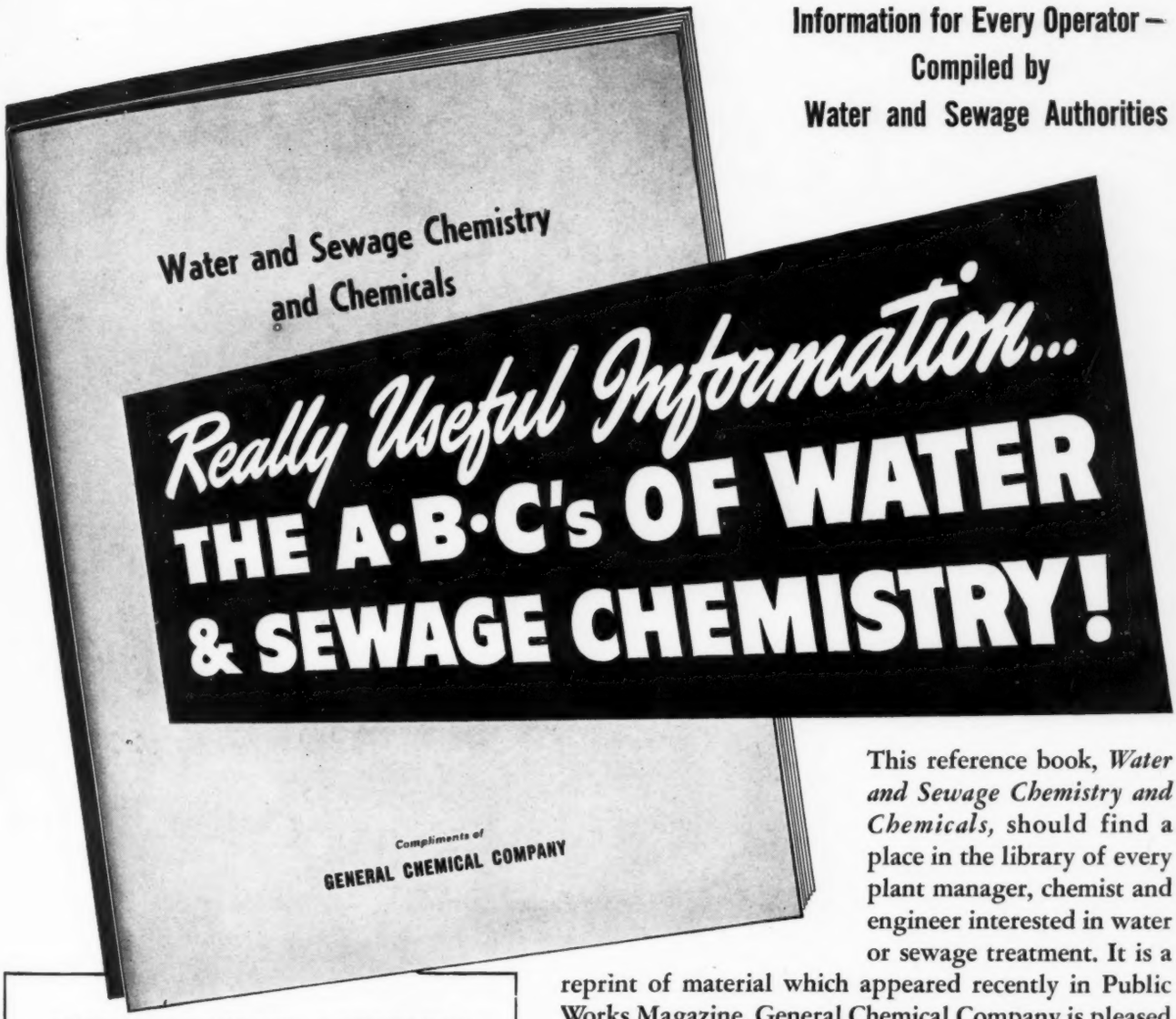
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The September issue of Water Works & Sewerage will be the Sewage Works Associations Convention Number.

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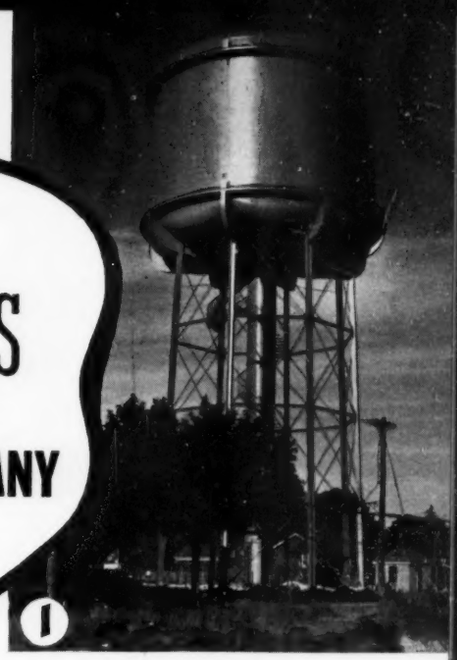

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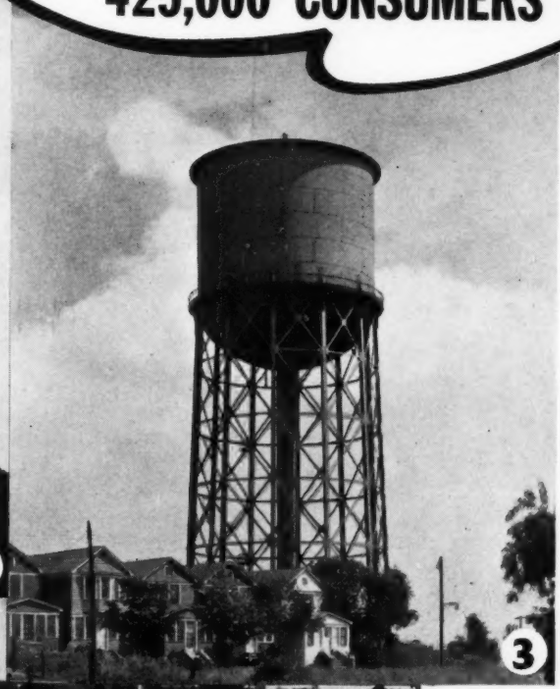
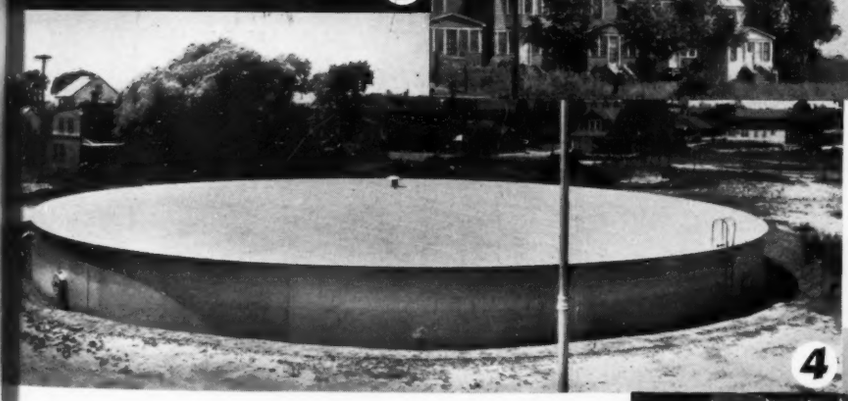


3

THE illustrations on this page show some of the Horton elevated tanks and steel storage reservoirs operated by the Jamaica Water Supply Company to provide efficient and economical service for its customers. This well-known company supplies water to a part of the Borough of Queens in the City of New York, and to several adjoining villages in Nassau County, all located on the western end of Long Island. Water supply is derived from 43 deep and shallow wells, distributed over an area of approximately 40 sq. miles, and having a total capacity of 71 m.g.d.

Approximately 425,000 consumers are served by this system, with a per capita consumption, including water used for fire protection, street flushing, and by metered consumers, of 70 g.p.d.



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● *If you are confronted with municipal water storage problems, let us furnish information or estimating data covering elevated or flat-bottom tanks to meet your requirements. Please call or write our nearest office. No obligation, of course.*

(1) Horton radial-cone bottom tank installed at New Hyde Park, L. I. Capacity, 1,250,000 gals. (2) 500,000-gal. Horton ellipsoidal-bottom tank at Hyde Park, L. I. (3) One of two 1,000,000-gal. tanks installed at Jamaica, N. Y. (4) 106.5 ft. diam. by 16 ft. high clear water storage tank at Jamaica. (5) 1,000,000-gal. underground steel reservoir installed at St. Albans, N. Y.

5

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J. R. Lower, Supervising Chemist, City of Bucyrus Water Works, Bucyrus, Ohio

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Bucyrus, Ohio is one of many cities and towns where Mathieson Chlorine plays a vital part in contributing to the efficient operation of municipal water works. And we are particularly proud of the reference to cylinders and valves—for trouble-free cylinders and valves have always been an integral part of Mathieson Chlorine service.

In Mathieson Chlorine you are assured of a pure product and prompt delivery service in addition to well-kept cylinders and valves. Many water works also keep Mathieson Sanitation HTH on hand for quick efficient service when water mains break or other emergencies arise. It is a free-flowing, mobile chlorine carrier containing over 70% available chlorine. We will be glad to send you full information on these two Mathieson sanitation products —Chlorine and HTH.

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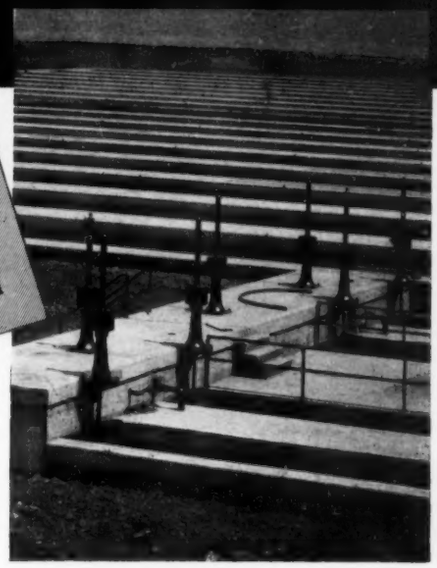

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Alert engineers and project officials have long guarded against operating failures and high maintenance costs by installing only equipment that has been proven in the field. That is why more and more cities have come back to Mueller for additional equipment—complete satisfaction with their original installations.

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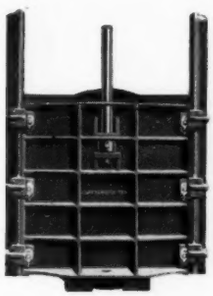

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The line of Mueller Sewage Disposal Equipment is quite complete. Regular standard sizes are usually available from stock and will often mean considerable savings to you. Years of priceless engineering experience and unequalled manufacturing facilities are at your disposal for any special problems or equipment. Submit your next problem or specifications to Mueller Co. for suggestions or quotations.

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MUELLER CO. CHATTANOOGA, TENN.

"SMART WATERWORKS OPERATORS

can have their cake and eat it, too" . . .

Many of you waterworks operators, especially smaller ones, have been told you could not get a drum of chlorine gas and have been told to use another source of chlorine. If this happened to you your situation is not an individual one, as you will note from the following quotations from July 22, 1941, letter written by Mr. H. E. Jordan, Secretary, American Water Works Association, 22 E. 40th Street, New York City, to Mr. Chas. A. Holmquist, Director, Division of Sanitation, Dept. of Health, Albany, N. Y.

"I have your letter of July 14th which relates that a sales representative of a chlorine jobber advised the operator of a certain swimming pool that his principals were not prepared to furnish liquid chlorine for the pool and suggested the use of chloride of lime or high test hypochlorite."

"*I think we should be prepared for temporary modification of the form of chlorine that is made available to consumers when stress makes such substitution necessary.* I doubt that any of us can expect favorable consideration of a demand that users of chlorine for sanitation purposes be at all times guaranteed the exact form of the chlorine that they wish, in the exact containers that they wish, from the exact producer that they favor . . . the sanitation field should not become alarmed if producers find it necessary to restrict the delivery of cylinder chlorine to slow-rate users and to *suggest the temporary use of other forms of chlorine* available for disinfection purposes."

You can "have your cake and eat it, too," if your equipment is such that you can use the chlorine you can get in whatever form available.

Don't wait until your supply of gas chlorine is shut off. Get ready now by installing standby, emergency CHLOR-O-FEEDERS so that you can go to sodium bleach or high test hypochlorite on instant notice . . . it won't cost you much and it may save you difficulties.

A pound of hypo you *can* get is worth far more than a cylinder of chlorine you *can't* get. But you *must* have available the equipment to feed what you can get.

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WATER WORKS & SEWERAGE

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E. S. Gillette, Publisher

EDITORIAL OFFICE
155 East 44th Street, New York, N. Y.
L. H. Enslow, Editor

COMING!

"Sewage Sludge Disposal at Sea"

Is the topic to be featured in our Sewage Works Federation Convention Number in a group of papers relating experiences and costs in connection with this method of sludge disposal at three New York City plants, and the Elizabeth Valley Joint Meeting and the Passaic Valley Sewerage Commission plants in New Jersey. Particularly interesting are the accounts of New York City's experiences with its impressive fleet of three sea-going vessels, their operations, cost data, etc. The authors—
HENRY LIEBMAN (New York City)
NATHAN I. KASS (New York City)
LESLIE E. WEST (Elizabeth Valley, N. J.)
J. RALPH VAN DUYNE (Passaic Valley, N. J.)

"An Adjudicator of Many Water Works Problems"

Is the sub-caption of an article which should sell many a flow recording "Meter-Master." This story is the most replete of any ever written, in disclosing the variety of applications of this information revealing water works instrument. What its revelations have meant in dollars and cents to a Water Department, as the result of more correct metering, compound meter shunting, checking, pump efficiency, etc., is told by
D. R. TAYLOR, Plant Superintendent, Water Dept. of Roanoke, Va.

"Industrial Waste Treatment Practices"

A series of articles to reveal progress in pollution abatement by the petroleum products industry and methods developed for treating petroleum production and refining wastes has already been begun by W. B. Hart and associates of the Atlantic Refining Co. The next in the series had been planned for this issue, but the authors, as the result of pressure of the defense program in the petroleum industry, have been unable to complete their article in time.

In our planning for authoritative articles which will give practical methods of treating various industrial wastes we have also been most fortunate in arranging for a valuable series of articles dealing with treatment of various types of wastes by a man of considerable experience in this phase of pollution abatement. Tanning, milk products, meat packing, canning, gas house, laundry and textile wastes, are amongst those to be covered. This authority has in effect "lived with" industrial waste treatment for the past several years. He is—
E. F. ELDRIDGE, Research Associate, Michigan Engineering Experiment Sta.

"Maintaining Meters"

In our next issue will appear another article dealing with "Meter Maintenance and Repairs." This article emphasizes the choice of proper test rates to employ, in consideration of the actual duty the meter is called upon to perform. That is, the important consideration is at what rates should the household meter be required to show greatest accuracy in order that most dollars will be rung up in the office cash register, and the least unaccounted for water stand in the water department records. The question of when and why it pays (and how it has paid) to replace important meter parts, comprises another enlightening section of this paper by—
LA VERNE TRENTLAGE, Supt. of Meters, Elgin, Ill.

"The New Filter Plant of Atlanta"

Will be featured in our October issue. This article which describes the plant, with particular reference to the unusual and novel features of design, equipment and methods of operation, is to be contributed by—
H. F. WIEDEMAN, Designing Engineer,
and
PAUL WEIR, Supt. of Filtration,
Atlanta, Ga.

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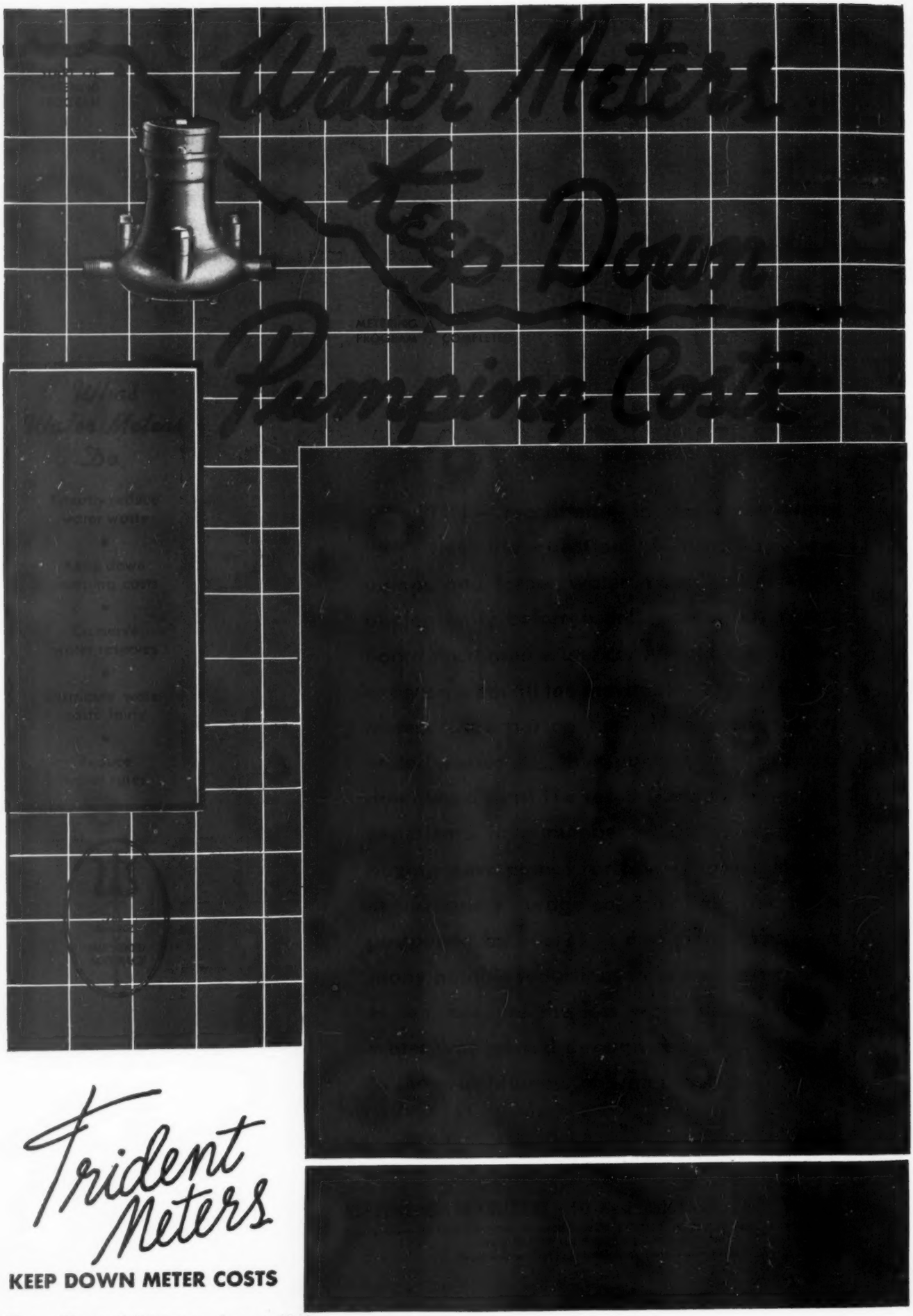
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KEEP DOWN METER COSTS

WATER WORKS & SEWERAGE

VOL. 88, NO. 8 *A Gillette Publication* AUGUST, 1941

OXIDIZED SLUDGE PROCESS AND THE "EQUILIBRIUM INDEX"

By EDWARD B. MALLORY
Director
LANCASTER RESEARCH LABORATORIES*
HACKENSACK, NEW JERSEY

Introduction

> *"When you can measure what you are speaking about and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind."*
>
> *—Lord Kelvin.*

Probably no problem in applied physics during the past twenty years, has represented greater evidence of the logic and wisdom in this frequently quoted remark by Sir William Thompson, than the activated sludge process for treating sewage.

Undoubtedly, the discovery of this process represented a great improvement over the older forms of sewage and waste treatment, and, during a fair proportion of the time, municipal plants employing this process have delivered reasonably satisfactory effluent, when operating at loadings not exceeding 50% to 60% of the properly rated capacity for which the plant was designed.

Theriault, Principal Chemist, United States Public Health Service, Stream Pollution Investigation Service, in an unpublished report filed in the public records at Tenafly, New Jersey, reviewed his work and studies made at the municipal treatment plant in the summer of 1931. In this report he defined the currently accepted standards of excellence of sewage treatment plant effluents as follows:

"A sewage effluent with a suspended matter content of 10 ppm. or less would ordinarily be rated as "Excellent"; the effluent would still be classed as "Good" when the suspended matter content was between 10 and 20; and it might be regarded as "Fair" with values ranging between 20 and 30."

Rapid strides were made in the scientific development of the fundamental principles and practices related to this aeration-sedimentation process, and a year later municipal treatment plant clarifier effluents having a suspended solids or 5-day B.O.D. concentration of 10 ppm., were regarded as "Poor."

*Subsidiary of Lancaster Iron Works, Inc., Lancaster, Pa.

Historical Review

During the decade from 1924 to 1934, a number of attempts were made to devise a yardstick by which the operating condition of sewage treatment plants employing the activated sludge process could be measured.

It is believed that Wagenhals, Theriault and Hommon[1] were the first to feel that a correlation of selected sludge characteristics could be interpreted as an index of the condition of the processing mechanism. They proposed, as a measure of process conditions, the ratio between the weight of the suspended solids in the mixed liquor, and the volume of sludge settled in a glass cylinder in thirty minutes, expressed in cubic centimeters per liter.

For convenience and uniformity in comparing sludge indices in this review, the following settling and concentration values will be assumed:

Mixed liquor suspended solids conc.....	2,500 ppm.
Return sludge suspended solids conc.....	10,000 ppm.
Settled sludge volume.....	250 cc/1

The Wagenhals et al, index, formulated and expressed in these values, becomes:

$$\text{Index} = \frac{\text{ppm. mixed liquor susp. solids}}{\text{settled sludge volume, cc/1}} = \frac{2500}{250} = 10.0$$

These authors undertook to classify sludge at one of the Houston, Texas plants, with the aid of this ratio, as follows:

Very good sludge	Index 40
Good sludge	Index 30
Poor sludge	Index 20
Very poor sludge	Index 10

Some years later, Donaldson[2] suggested a revised expression of the ratio proposed by Wagenhals et al. Observing the age-old academic axiom that it is illogical to divide apples by oranges to get lemons, he adopted a ratio between expressions of uniform character, and to identify the intent and purpose of the ratio, he designated the quotient by the expressive term, "Sludge Index."

The Donaldson "Sludge Index" is the ratio between the weight of the suspended solids in the mixed liquor,

expressed in per cent times 100, and the volume of sludge settled in a glass cylinder in thirty minutes, expressed in per cent of the total volume of mixed liquor in the cylinder. This index may be formulated and numerically expressed as follows:

$$\text{S.I.} = \frac{100 \times \%\ \text{mixed liquor susp. solids}}{\%\ \text{volume of settled sludge}}$$
$$= \frac{100 \times .25}{25} = 1.0$$

Fig. 1—Original Donaldson Blanket Finder
Still in use by Kenneth Adams, Supt. Sewage Treatment Works, Tenafly, N. J.

Donaldson also explored the possibilities of correlating the concentration of total solids in the mixed liquor with the sludge settling volume. This correlation suggested some advantage in accuracy at the hands of the non-technical sewage plant operator. In practice, it would result in a somewhat higher numerical value for the index, and a corresponding adjustment of the value regarded as optimum at individual plants.

Haseltine[3] undertook to combine the numerator of Wagenhals et al, and the denominator of Donaldson as determined in one hour instead of thirty minutes. Haseltine's index may be formulated and numerically expressed as follows:

$$\text{S.I.} = \frac{\text{ppm. mixed liquor suspended solids}}{\%\ \text{volume of settled sludge}}$$
$$= \frac{2500}{25} = 100$$

About two years later, Mohlman[4] proposed a transposition of the factors in the ratio between the suspended solids concentration by weight and the volume of settled sludge, according to Donaldson. This transposition provided an index conflicting with conventional interpretations of excellence. Wagenhals et al, Donaldson and Haseltine all undertook to define superior process conditions by higher sludge index values. In direct contrast, Mohlman undertook to define superior qualities by lower sludge index values. This index, in effect, evaluated the bulking propensities of the sludge. The Mohlman index may be formulated and numerically expressed as follows:

$$\text{S.I.} = \frac{\%\ \text{volume of settled sludge}}{\%\ \text{mixed liquor suspended solids}}$$
$$= \frac{25}{.25} = 100$$

Mohlman[4] credited Rudolfs with the authorship of another version of the sludge index: "computed as the quotient of the ppm. of suspended solids divided by the per cent of sludge settled in thirty minutes times 100." This version may be formulated and expressed numerically in the average values adopted, as follows:

$$\text{S.I.} = \frac{\text{ppm. mixed liquor susp. solids}}{100 \times \%\ \text{volume settled sludge}}$$
$$= \frac{2500}{100 \times 25.0} = 1.0$$

The Rudolfs index, as described by Mohlman, introduces no practical element of originality, since the factor "100" below the line serves only to divide the Haseltine index by 100.

Bloodgood[5] suggested an index or control test somewhat reflecting the theories recited in the United States Letters Patent cited by Edwards[8] and not inconsistent with a ratio employed during the early work at Tenafly in 1931-32. His factors may be formulated and expressed numerically as follows:

$$\text{S.I.} = \frac{\%\ \text{suspended solids in settled sludge}}{\%\ \text{suspended solids in return sludge}}, \text{ or}$$
$$= \frac{\%\ \text{suspended solids in mixed liquor} \times \left[\frac{\text{vol. of settling glass}}{\text{vol. of settled sludge}}\right]}{\%\ \text{suspended solids in return sludge}}$$
$$= \frac{.25 \times \left[\frac{1000}{250}\right]}{1.0} = 1.0$$

An index value of not less than 1.0 is prescribed as desirable.

Limitations

These indices exhibited numerous elements in common:

1. With one exception, they all reflected the belief that the operating conditions in an activated sludge processing cycle could be ascertained and numerically expressed by correlating the weight of the suspended solids in the mixed liquor, and the volume of solids which settled in a laboratory cylinder in a selected period.

2. In effect, they all represented a measure of sludge characteristics.

3. The tests, incident to a computation of these indices, were all made on specimens taken from the treatment tanks to the laboratory.

4. To arrive at the index value by any of these methods required from 30 minutes to 1 hour to determine the settling volume, and from 2 to 3 hours to determine properly the weight of the solids.

5. All required the use of more or less delicate and expensive laboratory equipment, restricting practical application in small municipal or industrial plants.

6. Without exception, all of these methods of index determination represented numerous errors of omission. These include:

(a) No compensation for the inherent characteristics of individual plant design, such as character and/or location of, (1) clarifier inlet ports, (2) decanting weir, (3) synartesis chamber, (4) mechanical and atmospheric disturbances, (5) the sequence of decreasing inherent efficiencies, under comparable load and flow conditions, of the various types of clarifiers—converging radial flow, across flow, and diverging radial flow.

(b) No compensation for the ratio of effective aeration periods to sludge settling periods.

(c) No compensation for the ratio of weight to surface area of sludge solids.

(d) No compensation for the synartesis factor in the plant clarifier.

(e) No compensation for solids distribution in the processing elements.

(f) No compensation for sewage flow rates.

(g) No compensation for return sludge flow rates.

(h) No compensation for rapidly and widely varying load conditions (B.O.D.) during a diurnal cycle.

(i) No compensation for the ratio of volatile solids to plant characteristics.

(j) No compensation for diverse physical and chemical reactions in the clarifier and, likewise, in the settling glass.

(k) No compensation for thermotropism or heliotropism.

(l) No mathematical or other method of predetermining optimum index values for a new plant, necessitating experimentation over an extended period of time, generally years.

(m) Lastly, and of importance equalling any of the foregoing, none of these indices could be determined in a few minutes, a prerequisite to control adjustments which are to be made without costly delay, and the desirability of making these as frequently as circumstances dictates.

Observations

While Wagenhals, Theriault and Hommon may be credited with the original germs of thought, that a correlation of the suspended solids concentration by weight in the mixed liquor and the sludge settling rate, could in some manner be employed to interpret process conditions, little was accomplished by these investigators in reducing this belief to practical application.

By virtue of a request by municipal authorities, to aid in a solution of the pressing problem at the Tenafly plant, it was the author's privilege to observe and study much of Donaldson's work, as well as the brief work of Theriault at this plant during the summer of 1931.

Throughout his work in that year, Donaldson maintained the courage of his convictions and persistently sought to establish a reliable method of process control, although cognizant of the limitations of the sludge weight-volume ratio. His work here and elsewhere was extensive, and much data of positive and negative character were developed. As frequently happens in research work, negative data may often be capitalized and converted into positive data by interpretation.

In his paper, "The Activated Sludge Process of Sewage Treatment," presented at the meeting of the Sanitary Engineering Division of the American Society of Civil Engineers, January 21, 1932, Donaldson broadly summarized observations derived from the work and discussions at Tenafly:

"The activated sludge process, probably to a greater extent than any other process of sewage treatment, is dependent for good plant performance upon the proper interrelationship of quite a number of different plant factors. Some of these relate to characteristics of the sewage to be treated. Still other factors relate to the characteristics of plant operation within the range of limits under control of the operators, subject to the sewage to be treated and the plant in which the treatment must occur."

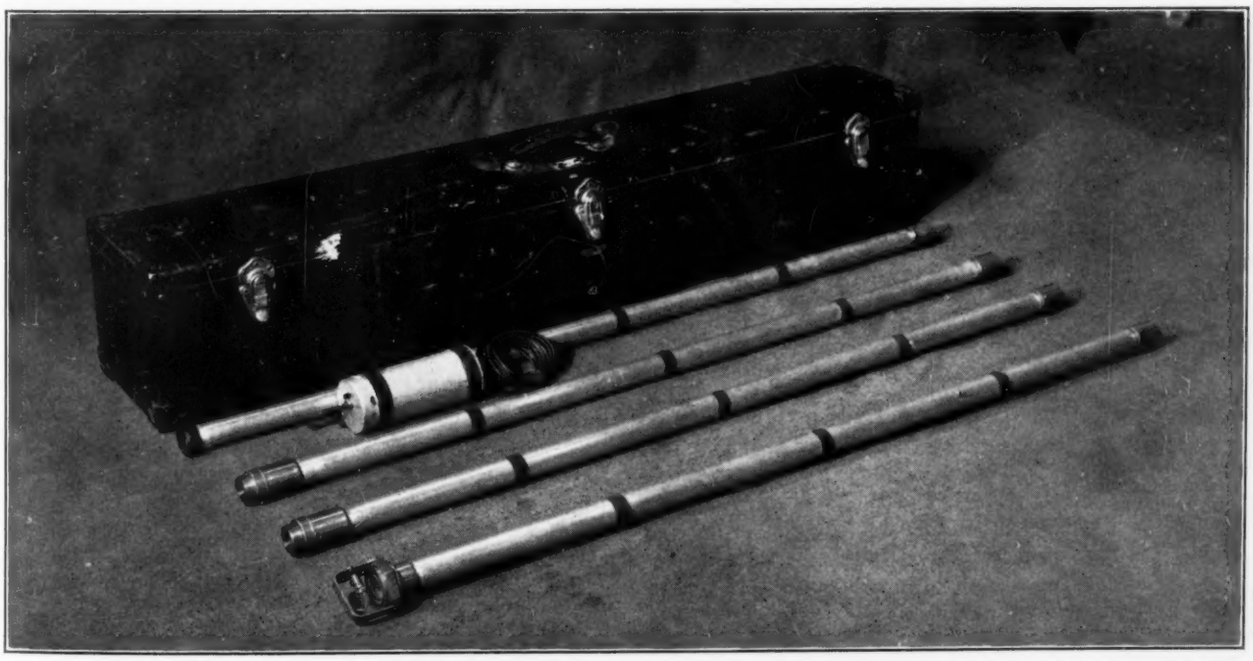


Fig. 2—Portable Blanket Finder
Developed by Lancaster Research Laboratories

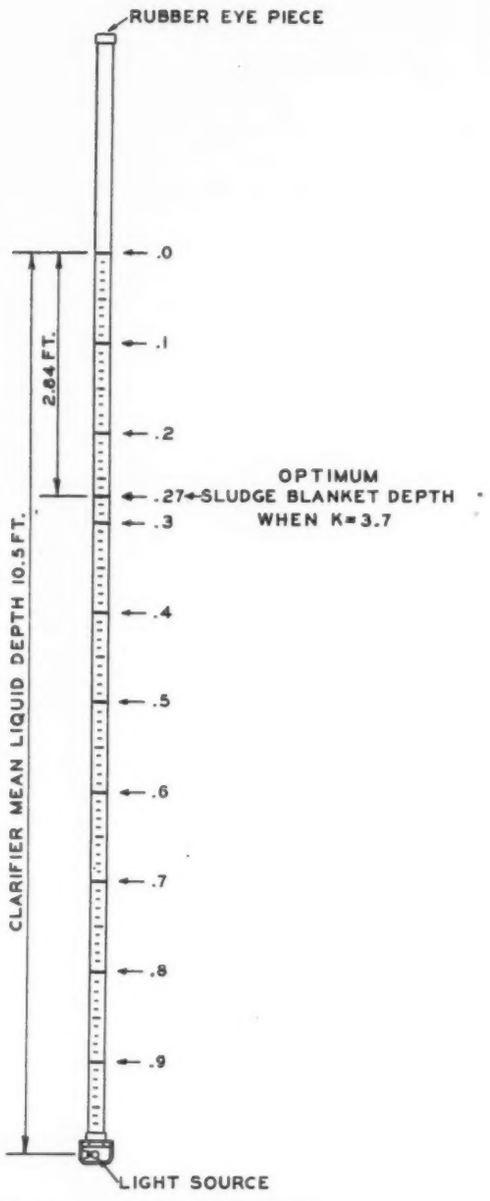


Fig. 3—Mallory Direct Reading Settling Indicator
Reads directly in "Blx" Values; with Optimum Index Indicated for Plant for Which Calibrated.

The writer has often wondered if many of his listeners fully appreciated the import of this statement.

It may be stated without qualification that Donaldson's original work contributed more constructive impetus to the discovery of the influential basic factors and the accurate correlation of such factors in reliable control measures, than that of any other worker in this field. The daily log record of the Tenafly plant for the year 1932 (Schedule C), which established what is believed to be a world's record for consistently superior performance and simplicity of control, bears lasting testimony to the inspiration afforded.

It may have been unfortunate that Haseltine encountered obstacles of serious moment in his explorations. A review of the design and loading data reported by Haseltine (Ibid.) reflects a substantial overloading on the treatment plant at which his studies were conducted. No doubt these studies had to be subordinated to the more pressing problems of providing some degree of treatment to the excessive load on the treatment plant.

The subsequently published sludge indices by Mohlman and Rudolfs vary, by definition, only to the extent of terminology and a choice of arithmetical arrangements.

Bloodgood's index differs from its predecessors to the extent that he correlates the suspended solids concentration of the returned sludge with the suspended solids concentration of the sludge settled in a specimen of mixed liquor for a selected period. A ratio of these elements, determined by properly compensated tests, can be of practical interest as a component factor in the determination of process conditions.

Development of New Theories

The work at Tenafly definitely pointed to the need for more reliable and more quickly determined measures of processing conditions. Analysis of Donaldson's work and continued explorations clearly showed that the single ratio between sludge weight and settling volume could not be sufficiently informative, and that a number of factors in the process must be maintained in measured balance and in balanced mutual relationship to insure optimum performance.

It was discovered that a principal controlling factor in the operations of this type of process, was *the relationship between the effective period of aeration and the effective period of sedimentation*, the multitude of physical and chemical reactions being largely responsive, both qualitatively and quantitatively, to this relationship.

It was further discovered that the relationship between the concentration of suspended solids maintained in the aerator and the concentration of suspended solids developed in the return sludge represented, at optimum performance conditions, a definite relationship to the aeration-sedimentation ratio.

It was further discovered that the optimum distribution of the amount of the suspended solids in the system between the aerator and the clarifier, represented a definite relationship to the aeration-sedimentation period, and also that the ratio of the contents of the clarifier to the volume of sludge settled in the clarifier, was related to these factors. More particularly, it was discovered that these various ratios were mutually related and inter-acting, and jointly responsive to load variations.

Another fact of associated interest discovered, was that the rate of dewaterization of excess sludge on filters could be increased to unbelievable proportions, and reliably and consistently accomplished, by determining the electrolyte admixture by the correlation of process factors and a measure of the physical characteristics of the sludge. Description of the tests employed and the results obtained will be reported in a later paper under the general subject of "Oxidized Sludge Dewaterization."

An element of especial importance to the designing engineer was discovered, that relative B.O.D. loadings could be computed from quickly measured plant factors at any particular time, and that the full load capacity of a projected plant could be accurately predetermined. These computations are so accurate and sharply defined that a persisting overload of 5% will be noticeably detrimental to the plant effluent. In the design of a new plant it is now possible to predetermine (1) the

optimum mixed liquor concentration at any loading value up to the full load capacity; (2) the optimum ratio of return sludge flow to sewage flow; (3) the optimum volume of suspended solids in the system (this also determines the volume of excess sludge to be discarded and the time of discard); (4) the optimum sludge blanket volume at varying loadings, and other factors of design and control.

With a knowledge of the amount and concentration of load to be treated, and this knowledge of design factors, precision in design and certainty in performance guarantees becomes an accomplished fact. The performance guarantees of 99% suspended solids and/or B.O.D. reductions, currently offered by the company with which the writer is associated, are predicated on knowledge of these basic and studied factors.

This knowledge has also led to the design of treatment tanks of greatly improved efficiencies. Conventional plants exhibit a ratio of 35 to 75 cubic feet of aeration tank holding capacity per pound of B.O.D. per day. Contrasted with this, plants put into operation during the past two years exhibit ratios as low as 5 to 10 cubic feet per pound. Older plants exhibit ratios of 800 to 1500 cubic feet of air per pound of B.O.D. per day. Advanced practice in recent designs reflects ratios as low as 200 cubic feet per pound.

The "Equilibrium Index"

Continued exploration confirmed the belief that a theoretically optimum condition of the activated sludge process could only obtain when each of the ratios of physical factors were individually and mutually in balance. These factors were appropriately combined in an "Equilibrium Index," an expression coined to define the condition of the process and the numerically expressed degree in which it deviates from equilibrium. This "Equilibrium Index" may be expressed as follows:

$$Eqx = \frac{R^2D}{BMK}$$

Wherein:

A = Aeration period in hours.

B = Sludge blanket volume (cu. ft. or gals.).

C = Sedimentation period in hours.

D = Clarifier liquid volume (same basis as "B").

$$K = \text{A constant,} \left(\frac{2A}{C} - 1 \right)$$

M = Mixed liquor suspended solids concentration in per cent.

R = Return sludge solids concentration in per cent.

Eqx = "Equilibrium Index."

The mixed liquor and return sludge suspended solids concentrations are preferably determined by the "Standard Centrifuge Test" described in U. S. Letters Patent 2154132.

At the optimum value (i. e.—when the process is in equilibrium) the "Eqx," 100, resembles the numerical value of the Haseltine sludge index. It represents an approach to 100% efficiency in balanced performance with due regard for operating costs. Conditions above equilibrium, representing a reserve factor of safety and increased ability to withstand overload shocks, are represented by values in excess of 100. Conditions below equilibrium, requiring thought and attention on the part of the operator, if more than temporary, are expressed in values below 100.

The knowledge that the process is not in equilibrium is, in itself, informative, but not instructive in defining the remedial measures required to restore balance. It

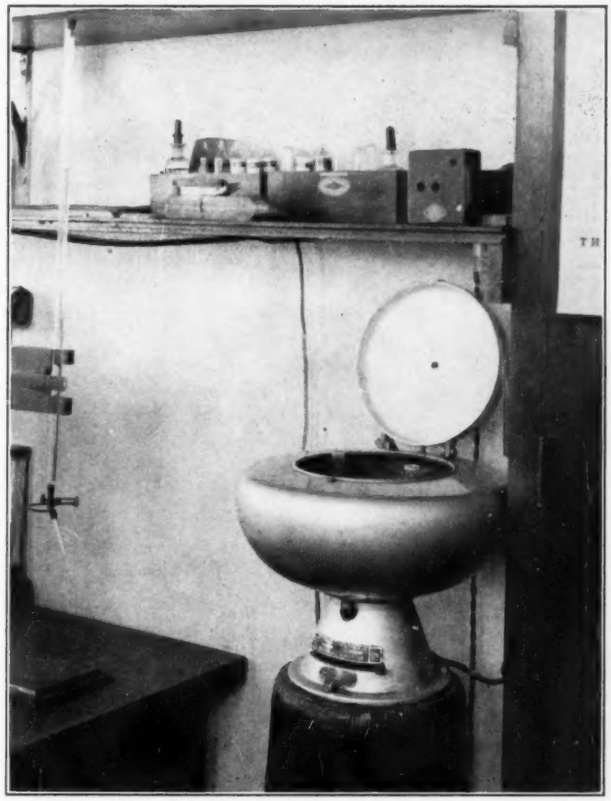


Fig. 4—Original Centrifuge Still in Service at Tenafly

is necessary to know which factors are out of balance and the degree in which each is out of balance. Correction of no more than the principal factors in a small plant will generally be sufficient to restore equilibrium. In larger plants, the various other factors may also be individually examined and properly compensated.

Many operators will prefer a division of the "Equilibrium Index" into its component elements—the "Settling Index" ("Blx"), the "Solids Distribution Index" ("Sdx"), and the "Effective Settling Index" ("Cos").

The "Settling Index" is:

$$Blx = \frac{B}{D}$$

For convenience, the ratio of sludge blanket mean depth to clarifier mean liquid depth may be substituted when clarifiers have a substantially uniform horizontal cross section from top to bottom.

The "Solids Distribution Index" is

$$Sdx = \frac{R}{MK}.$$

It defines the ratio of solids distribution to the optimum value.

The "Effective Settling Index" (compensated observed settling), is the quotient of the "Settling Index" divided by the "Solids Distribution Index." It is expressed:

$$Cos = \frac{BMK}{DR}$$

The "Equilibrium Index" is the quotient of the concentration of suspended solids in the return sludge, in per cent, divided by the "Effective Settling Index," i.e.:

$$Eqx = \frac{R}{\left(\frac{BMK}{DR} \right)} = \frac{R^2D}{BMK}.$$

Typical full load equilibrium characteristics at the

Fig. 5—Portable Centrifuge
Employed by Lancaster Research Laboratories in Field Survey and Test Work.

Tenafly plant, at the time of the tests recited herein, proved to be:

A—Aeration period = 2.35 hr.
B—Blanket depth = 2.84 ft.
C—Sedimentation period = 1.0 hrs.
D—Clarifier liquid depth = 10.5 ft.

$$K\text{—Plant constant } \left(\frac{2A}{C} - 1\right) = 3.7$$

M—Mixed liquor suspended solids concentration, in per cent (approx. 4160 ppm.) = 7.3%
R—Return sludge suspended solids concentration, in per cent (approx. 15,400 ppm.) = 27.0%.
Eqx—Equilibrium index = 100.0.

Employing these values, the various indices may be expressed numerically as follows:

$$Blx = \frac{B}{D} = \frac{2.84}{10.5} = .27$$

$$Sdx = \frac{R}{MK} = \frac{27.0}{7.3 \times 3.7} = 1.0$$

$$Cos = \frac{BMK}{DR} = \frac{2.84 \times 7.3 \times 3.7}{10.5 \times 27.0} = .27$$

$$Eqx = \frac{R^2D}{BMK} = \frac{27.0^2 \times 10.5}{2.84 \times 7.3 \times 3.7} = 100.0$$

In practice, particularly at plants in which the loading and the flow varies over a wide range during the daylight hours, it is desirable to determine and record these data hourly. Under critical conditions of loading, it is very helpful to plot these values, to follow more readily the trend and to observe the efficacy of the control measures employed in accommodating load and flow changes. The reader is referred to the United States Letters Patent cited by Edwards[8] for information relative to the determination of essential values at varying loads and the application of appropriate ratios in prescribing the removal of excess sludge and other processing adjustments.

Three Simple Tests Involved

It has been shown that three simple tests, two of which may be made simultaneously, and all of which may be completed in less than ten minutes, are sufficient to provide all of the information necessary, with complete compensation for the influential factors previously recited. The "Sludge Blanket Finder," described by Vermilye[6], was devised and originally employed by Donaldson and Kurtz at the Tenafly plant. This simple and effective device serves admirably to quickly and accurately measure the sludge blanket depth, for determining the ratio of sludge blanket volume to total liquid volume of the clarifier.

Fig. 1 could very properly be entitled "Teaching a New Dog Old Tricks." This picture, taken in February, 1941, shows Kenneth Adams, superintendent of the Sewage Treatment Works of Tenafly, N. J., using the original Donaldson blanket finder to measure the sludge blanket depth in the new Dorr clarifier installed at this plant during the past year. This blanket finder has been in constant daily (bi-hourly) service since it was adopted as a regular test device in January, 1932.

Fig. 2 illustrates a somewhat more pretentious blanket finder, designed and employed as portable field equipment by the Lancaster Research Laboratories, in conducting treatment plant tests and instituting control technique.

Licensed manufacturers of "Oxidized Sludge Process" treatment plants furnish the "Mallory Direct Reading Settling Indicator" (blanket finder) (Fig. 3). These instruments have a scale reading directly in "Blx" values at the liquid surface of the particular clarifier for which they are calibrated, with a special index designating the optimum "Blx" value for that particular plant.

The "Combined Blanket Finder and Turbidimeter" proposed by Bloodgood[7] could hardly be of practicable use as a blanket finder. The battery housing would cause a hole in the blanket and introduce serious errors in the reading. If the instrument was of sufficient length to accommodate tanks six feet or more in depth, it would be inoperative in a turbid supernatant liquor long before the blanket surface is reached.

During his work at Tenafly, Donaldson attempted experimentally to correlate the suspended solids concentration of sludge, as determined by centrifuging, with the concentration determined by weight. Early observations and experiments developed the viewpoint, then regarded by many as unorthodox, that the concentration determined by centrifuging was the more accurately informative of the two in evaluating process factors. When the revised operating technique, somewhat harmonious with the theories and principles recited herein, was adopted at Tenafly, January 1, 1932, an "International Clinical Centrifuge," equipped with two 15 ml. standard A.P.I. tubes, previously employed by Donaldson, was permanently established on a cast concrete pedestal in the laboratory. *All conventional test equipment and methods were then discarded.* Since that time, all essential control tests have been made with the sole aid of the centrifuge and the Donaldson blanket finder.

Fig. 4 shows the original centrifuge installation still in daily service ten years later. Fig. 5 shows a portable outfit employed in field survey and test work.

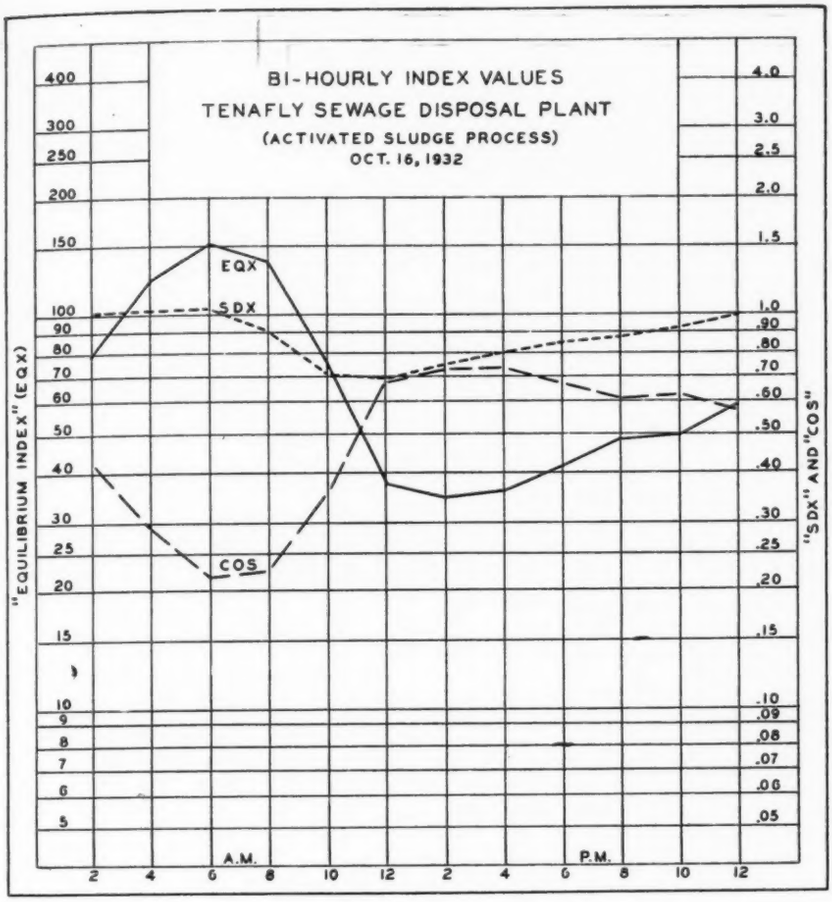


Fig. 6—Bi-Hourly Index Values, Tenafly, N. J.—Fig 7

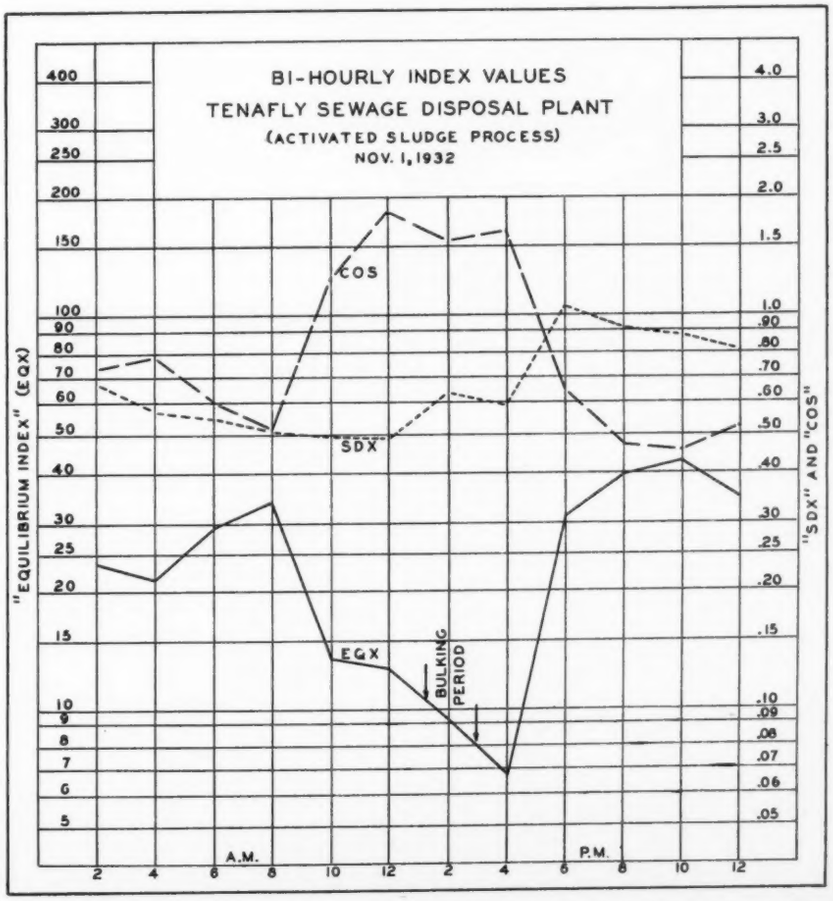
Informative Value of "EQX"

It has been demonstrated that an activated sludge process, operating under widely varying loading and flow conditions, may be reliably controlled indefinitely, within a narrow range of index values. Storm flows, heavy discharges of industrial wastes and other troublesome factors may be quickly detected and readily accommodated. It has also been demonstrated that plants in the immediate charge of novice non-technical attendants may be controlled with equal precision by telephone from geographically remote points, providing the plant attendant makes and reports the three simple tests, at required intervals, and employs the control measures prescribed.

As late as August, 1940, Keefer[9] states:

"Little is known about the causes of sludge bulking. During periods of bulking large quantities of sludge overflow from final-sedimentation tanks and contaminate the effluent."

"The bulking of sludge is the most baffling problem that confronts the operator at an activated-sludge plant. The condition frequently occurs unexpectedly and is often difficult to correct."



It will be shown that bulking is man-made, and that under normal plant operating conditions and starting with the process substantially in equilibrium, a period of ten days to two weeks is required to develop bulking, even when appropriate control measures are not adopted. It will also be shown that bulking, if purposely permitted, may be restrained and completely stopped within a few hours; and, under normal loading conditions, the process returned to equilibrium in one, or at most, two 24-hour periods.

This last statement must be qualified by certain limiting factors. It is quite frequently noted that new treatment plants are "designed for a return sludge flow of 20% of the sewage flow." Few, if any, of these designs have exhibited optimum characteristics of this value. Obviously it would be difficult, and perhaps impossible, to stop bulking in an hour or two in a plant having an inherent return sludge flow demand of 40%, with an air supply and return sludge equipment limited in capacity to 20 or 25%. The same would be true in plants in which the minimum air supply or sludge return equipment capacity was

greatly in excess of the optimum demand rate.

Fig. 6 illustrates graphically the trend of the "Equilibrium Index," represented by the solid line, the "Effective Settling Index," indicated by the dash line, and the "Distribution Index," represented by the dotted line, during the first day of a test period, in which bulking was invited for purposes of demonstration to distinguished observers, and further to demonstrate the prompt effect of appropriate remedial measures.

It will be observed that during the diurnal cycle on October 16, the "Equilibrium Index" varied from a minimum of approximately 35.0 to a maximum of approximately 150.0. The "Effective Settling Index" varied from a minimum of 0.23 to a maximum of 0.74, and the "Distribution Index" varied from a minimum of 0.69 to a maximum of 1.04. The bi-hourly changes reflected the effects of the variations in loading and flow rates, in the absence of appropriate hourly compensation.

Omitting interim data which exhibited progressively decreasing "Eqx" values, it will be observed (Fig. 7) that on November 1, the "Equilibrium Index" dropped from 35.0 at 8:00 A. M. to 13.0 at noon. The blanket commenced to pass over the weirs at 1:15. In the absence of proper corrective measures, bulking continued until after the regular hourly specimens were taken for the daily composite at the 2:00 o'clock sampling period. Immediately following the collection of these samples, appropriate remedial measures were prescribed. The discharge of sludge in the effluent was stopped before 3:00 o'clock. It will be noted that the "Distribution Index" was restored from a value of about 0.60 at the time corrective measures were adopted, to above equilibrium at 6:00 P. M.

The "Equilibrium Index" followed the trend of the "Distribution Index," and after a short inherent lag period, exhibited a sharp rise up to the 6:00 o'clock sampling period.

The night operator coming on duty, either through misunderstanding of the instructions left for him or the adoption of his own ideas, failed to conform to the prescribed operating program. A prompt indication was evident in the reversal of direction of the "Distribution Index" after 6:00 o'clock, even though the flow rates were progressively decreasing during the evening sampling periods. It will be noted that the rate of increase of the "Equilibrium Index" was arrested at 8:00 o'clock, further arrested at 10:00 o'clock, and the trend inverted at 12:00 o'clock. The lower flow rates during the night hours prevented these indices from again reaching dangerous levels, and with the restoration of the prescribed control measures the following morning, the process was returned to equilibrium during the day. In the records for November 1, 1932 (Schedule C), the sludge passing out in the effluent during the sampling period at 2:00 o'clock is reflected in the test of the composite sample, which exhibited a suspended solids concentration of 50 p.p.m. for the 24-hour period ending at 12:00 midnight. The record for the following day will confirm the reestablishment of proper performance.

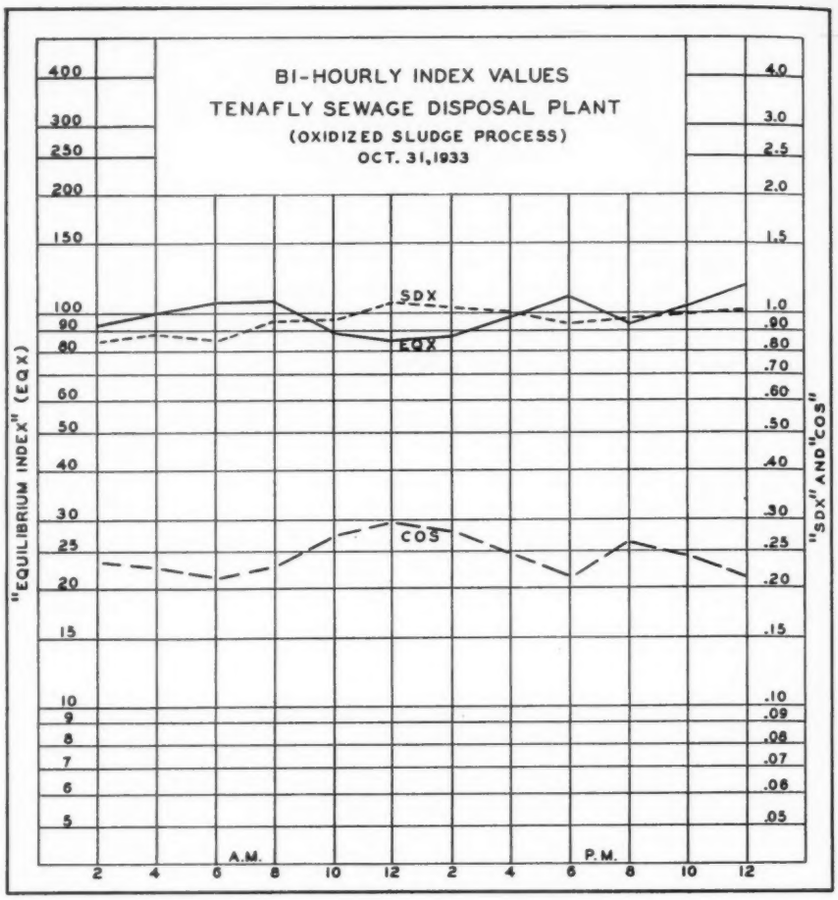


Fig. 8—Bi-Hourly Index Values, Tenafly, N. J.
(Plant Operating on Even Keel)

It will be evident that bulking was clearly shown to be imminent by increasingly impressive measures of process condition from day to day during the two-week period of test. It should also be evident that any slight tendency toward bulking may not only be detected days in advance, but that bulking may be widely avoided by maintaining the process approximately in equilibrium. The range of process deviation from absolute balance may, in reality, be consistently maintained within very narrow limits.

For purposes of direct and seasonal comparison, Fig. 8 illustrates graphically the bi-hourly values of the "Equilibrium Index," the "Distribution Index," and the "Effective Settling Index," one year later, when appropriate hourly control measures were employed.

It may be said that variation of the process equilibrium from an "Eqx" value of 75.0 to 125.0 is simple to maintain, but difficult to detect from a visual inspection of the process by the average observer. At a "Blx" below the value $\frac{0.8}{K}$, straggler floc will begin to appear in the effluent somewhat in proportion to the rates of flow through the clarifier. An increase in the "Eqx" above 150.0 will begin to exhibit pin floc and turbidity in the effluent, also somewhat in proportion to the excess value. Bulking may be regarded as remote at an

"Eqx" as low as 50.0, and still an impossibility above 25.0.

It is shown that optimum sludge characteristics will vary at different plants, and that comparisons of such characteristics, unless reduced to a common basis, are misleading. Uniform terminology, predicated upon numerical values, may now be adopted to distinguish between the terms "Bulky" and "Bulking." A "Bulky" sludge may be defined as having an "Effective Settling Index," "Cos," equivalent to twice the value of "Cos" at equilibrium. "Bulking" would express the actual occurrence of the sludge blanket passing over the clarifier weir (Blx = 1.0). In Figs. 6, 7 and 8, "Bulky" sludge would be indicated at "Cos" values above 0.54, i.e.,

$$\left(\frac{2BMK}{DR} = \frac{2 \times 2.84 \times 7.3 \times 37}{10.5 \times 27.0} = 0.54 \right)$$

Control of Equilibrium Index

The ability to control a process at will, through a wide range of stability, was regarded as an unique situation, offering great opportunity for the exploration of process factors under predetermined conditions. In the Spring of 1933, State authorities requested a demonstration of the control measures employed at Tenafly, with the particular object of determining what, if any, variations could be observed in the biological inclusions and chemical analyses of the sludge in the plant at various degrees of "Equilibrium." During the five month period, July to November, this plant was operated at various predetermined equilibrium index values, varying from 25 to 150% in steps of approximately 25%.

For purposes of direct and seasonal comparison, the performance records for these five month periods, July to November, in the two years prior to the employment of the advanced technique, and the two years during which it was demonstrated, are reproduced in Schedules A, B, C and D.

The problem which confronted Donaldson in 1930 is disclosed by a study of the flow rates and clarifier effluent suspended solids concentrations in that year. Examination of Schedule A indicates flow rates varying from 247,000 g.p.d. to 308,000 g.p.d. The aeration period varied from 9.3 hours to 8.5 hours. The sedimentation period varied from 4.5 hours to 3.6 hours. The suspended solids concentration in the clarifier effluent varied from 3 p.p.m. to 256 p.p.m., averaging 43 p.p.m.

The beneficial influence of the Donaldson "Sludge Index" during the year 1931 is clearly apparent from Schedule B. The flow rates varied from 245,000 g.p.d. to 555,000 g.p.d. The aeration period varied from 10.8 hours to 4.8 hours. The sedimentation period varied from 4.6 hours to 2.0 hours. The clarifier effluent suspended solids concentration varied from 3 p.p.m. to 162 p.p.m., averaging 16 p.p.m., or about 37% of the 1930 average.

Control measures, related to the discoveries recited in preceding paragraphs, were introduced experimentally on January 1, 1932. It will be observed from Schedule C that the flow rates and loading continued to increase as more services were connected to the sewerage system. The flow rates varied from 230,000 g.p.d. to 869,000 g.p.d. The aeration period varied through a wider range, from 11.5 hours to 3.0 hours. The sedimentation period varied from 4.8 hours to 1.3 hours. The clarifier effluent suspended solids concentration varied from 1 p.p.m. to 17 p.p.m., averaging 4 p.p.m. This represents a reduction of 75% from the 1931 average value and 90% from the 1930 average value.

During the period of test and demonstration requested by State authorities in 1933, it will be observed from Schedule D that the flow rates varied from 370,000 g.p.d. to 1,506,000 g.p.d. The aeration period varied from 7.0 hours to 1.8 hours. The sedimentation period varied from 3.0 hours to 45 minutes. The clarifier effluent suspended solids concentration varied from 1

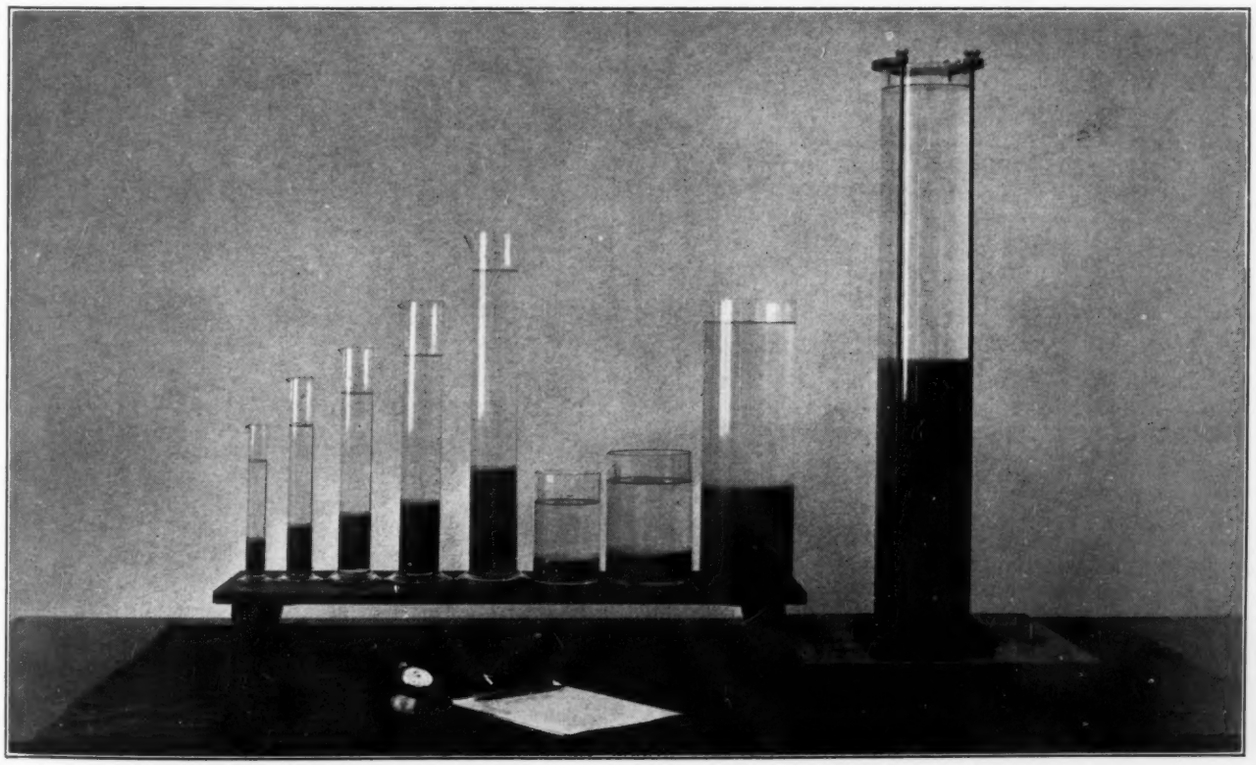


Fig. 9—Comparison of Standard Laboratory Cylinders and Improved "Settlometers"

SEWAGE TREATMENT PLANT
TENAFLY, NEW JERSEY
(Oxidized Sludge)

Performance Record
Daily Flow Rate and Clarifier Effluent
Suspended Solids Concentration

SCHEDULE A — 1930	July		Aug.		Sept.		Oct.		Nov.		SCHEDULE B — 1931	July		Aug.		Sept.		Oct.		Nov.	
Day	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Day	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.
1	342	35	240	20	258	6	310	23	285	102	1	-	19	245	22	402	17	347	17	382	23
2	314	27	246	17	272	8	310	25	258	17	2	-	12	307	15	430	23	326	5	386	16
3	311	22	224	29	286	5	300	21	297	95	3	442	7	360	29	426	6	363	2	381	13
4	285	15	256	33	251	5	322	24	290	86	4	437	11	221	26	436	25	347	3	288	11
5	277	10	244	33	258	13	303	98	286	66	5	418	10	348	13	419	10	309	7	346	7
6	296	9	242	26	280	10	300	80	273	51	6	456	6	330	16	402	4	327	4	341	19
7	302	13	227	24	275	60	289	140	305	25	7	444	8	413	36	396	6	328	5	354	9
8	286	90	245	33	262	21	283	105	304	22	8	443	4	377	28	396	61	328	5	365	8
9	275	13	282	24	282	9	286	77	242	21	9	426	4	400	20	390	106	336	4	370	28
10	284	20	254	29	216	3	275	36	275	45	10	454	10	425	27	386	90	360	7	351	9
11	264	43	244	96	259	4	264	61	301	29	11	454	15	457	26	373	63	322	9	348	7
12	283	50	233	77	251	3	260	27	285	19	12	409	3	436	17	353	4	360	5	350	5
13	275	51	229	47	265	3	294	30	282	19	13	444	7	408	76	296	87	328	20	319	3
14	270	89	223	89	254	3	271	8	289	6	14	418	14	455	169	411	-	313	19	337	3
15	274	27	248	49	274	6	276	15	293	18	15	404	23	440	45	391	16	364	11	382	3
16	253	35	258	42	280	4	298	8	363	52	16	390	9	444	15	401	17	373	7	299	5
17	242	25	239	57	271	10	291	3	467	213	17	379	7	445	9	390	11	379	9	295	4
18	247	67	257	59	271	3	285	3	421	243	18	371	34	427	7	401	12	376	25	302	3
19	263	71	249	31	255	10	261	5	365	256	19	306	15	555	4	383	14	386	10	286	4
20	242	22	229	27	269	6	264	18	383	190	20	413	13	485	3	376	13	356	7	275	52
21	267	29	236	22	265	10	242	12	353	201	21	433	5	465	3	396	14	345	10	279	13
22	256	62	245	63	266	15	243	15	389	135	22	436	5	454	3	385	3	327	12	265	7
23	241	66	374	71	286	25	249	10	330	31	23	403	5	435	4	366	7	342	7	306	9
24	262	75	291	20	229	7	285	17	361	119	24	390	5	439	9	353	5	377	7	257	19
25	280	47	305	16	261	15	269	21	319	68	25	374	6	441	9	343	20	366	25	249	86
26	270	57	292	17	279	3	245	38	342	66	26	354	13	432	9	396	3	364	30	348	19
27	249	89	282	23	289	3	288	54	357	112	27	343	16	424	10	367	3	345	25	283	33
28	247	97	267	13	260	7	250	43	299	80	28	340	16	422	9	379	7	349	5	285	13
29	246	29	271	9	296	27	262	27	309	35	29	330	17	415	32	347	4	366	4	259	5
30	251	96	273	9	306	27	265	32	329	60	30	362	10	422	7	340	4	356	7	265	5
31	243	63	283	5	-	-	267	48	-	-	31	294	11	421	15	-	-	392	5	-	-
Average	272	45	247	36	269	11	279	36	306	83	Average	405	10	420	23	382	23	366	10	316	18

Schedules A and B—Performance Records—Oxidized Sludge Process at Tenafly, N. J.—Daily Flows in 000 G.P.D. and Suspended Solids in Effluent

SEWAGE TREATMENT PLANT
TENAFLY, NEW JERSEY
(Oxidized Sludge)

Performance Record
Daily Flow Rate and Clarifier Effluent
Suspended Solids Concentration

SCHEDULE C — 1932	July		Aug.		Sept.		Oct.		Nov.		SCHEDULE D — 1933	July		Aug.		Sept.		Oct.		Nov.	
Day	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Day	Flow gpd.	Susp. Sol. ppm.	flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.	Flow gpd.	Susp. Sol. ppm.
1	408	2	325	4	296	3	299	4	431	50x	1	629	3	487	1	549	2	766	1	585	2
2	440	2	227	4	378	3	276	5	448	1	2	803	5	480	1	540	2	807	2	568	3
3	440	3	298	3	273	5	275	3	392	2	3	702	1	451	1	557	2	750	2	571	5
4	411	2	311	3	230	8	253	5	408	1	4	678	1	461	1	761	2	736	3	561	1
5	434	2	293	1	244	3	248	3	380	1	5	653	1	450	2	735	1	758	2	559	6
6	400	2	304	2	273	4	309	5	383	3	6	656	1	414	3	674	1	771	2	586	5
7	400	3	289	3	241	8	310	3	606	17	7	642	1	444	3	633	2	745	2	574	3
8	388	3	320	2	263	8	294	2	550	2	8	689	1	426	2	611	2	723	1	568	2
9	399	1	289	1	261	6	282	3	494	2	9	666	1	419	1	643	1	713	1	568	7
10	361	3	300	3	265	3	288	7	808	2	10	612	2	417	2	595	1	675	2	554	4
11	405	3	323	3	265	3	287	3	669	2	11	561	3	443	2	599	2	665	2	548	5
12	367	2	288	3	269	5	280	2	630	1	12	549	1	441	2	560	2	664	2	532	4
13	362	2	289	3	254	4	286	2	555	1	13	553	3	425	2	550	2	649	1	561	5
14	366	2	269	2	267	4	277	2	570	2	14	527	3	454	2	626	1	662	1	537	4
15	344	1	293	6	273	7	279	1	524	1	15	537	2	439	2	1477	2	638	4	526	5
16	359	2	280	7	273	3	277	2	553	2	16	556	1	431	3	1506	3	653	3	513	6
17	360	5	300	3	288	3	310	2	509	1	17	529	1	431	2	1314	2	682	5	515	5
18	356	3	282	4	264	3	538	5	496	2	18	530	2	370	1	1247	4	701	5	526	1
19	307	3	286	3	268	3	410	2	869	3	19	515	2	421	2	1128	3	672	8	525	2
20	325	2	296	3	271	4	372	2	535	4	20	525	1	390	2	1074	5	646	5	530	3
21	393	3	276	5	255	1	365	3	793	1	21	522	1	430	1	1019	3	646	7	517	5
22	321	3	305	15	268	1	365	3	725	2	22	497	1	688	3	971	3	633	3	515	3
23	382	1	296	6	271	1	343	2	673	2	23	480	1	675	3	932	1	611	5	508	3
24	313	2	267	6	278	2	352	3	670	3	24	497	2	1000	3	937	2	644	5	505	1
25	344	11	266	6	267	1	331	3	653	1	25	467	2	826	4	907	2	652	8	517	4
26	321	5	278	7	280	1	333	3	657	1	26	477	1	700	2	850	2	635	3	503	3
27	310	2	276	3	253	1	355	3	619	3	27	402	1	632	3	862	1	621	3	504	3
28	315	3	286	6	296	1	378	2	611	2	28	469	1	634	3	834	2	622	2	498	6
29	308	7	263	7	276	7	373	2	562	3	29	486	1	594	3	808	2	597	1	502	6
30	317	4	286	3	264	3	354	3	563	1	30	451	1	568	3	795	2	616	2	508	3
31	305	3	273	3	-	-	327	3	-	-	31	494	1	543	1	-	-	589	3	-	-
Average	360	3	287	4	267	4	322	3	586	4	Average	564	2	518	2	843	2	675	3	556	4

Schedules C and D—Performance Records——Oxidized Sludge Process at Tenafly, N. J.—Daily Flows in 000 G.P.D. and Suspended Solids in Effluent

p.p.m. to 8 p.p.m., averaging 3 p.p.m., or a further reduction of 25% from the preceding year. This record reveals a reduction of 95% from the 1930 average.

The screened sewage loading during this test period represented approximately 92% of the full load capacity of the secondary or activated sludge process. The suspended solids concentration varied from 110 to 180 p.p.m., averaging 135 p.p.m. The B.O.D. concentration varied from 110 to 195 p.p.m., averaging 156 p.p.m. The effluent suspended solids concentration averaged 3 p.p.m. and the B.O.D. 6 p.p.m., representing reduction efficiencies of 98% and 96%, respectively. During periods of high raw sewage concentrations, these efficiencies exceeded 99% and 98%, respectively. The D.O. at the aerator outlet varied from 0.4 p.p.m. to 1.1 p.p.m., and averaged 0.86 p.p.m. for the five month period.

All flow and effluent suspended solids concentration data in these schedules are taken from the plant log records of daily tests by the regular plant operators. The screened sewage suspended solids concentration, the effluent B.O.D. and the D.O. data are from tests by State investigators. Bacteriological and protozoological studies were also conducted by State investigators during this series of tests. It was clearly shown that no correlation existed between "Equilibrium" values and the biological inclusions.

Summary of Tests

It is the general impression that results obtained in the laboratory are seldom equaled in practice. To remove all elements of doubt, the data recited have been selected from a mass of equally conclusive plant records of performance under actual operating conditions. These selected data include, for comparison, the two years prior to the employment of the control practices described and the two years during which they were employed. The same seasonal period of each year was selected to conform to the period during which State investigators conducted their tests.

The intentional bulking demonstration was selected to exhibit the wide latitude of this process as it may now be accurately measured, the long advanced warning of bulking, the prompt response to appropriate control practice and the simplicity and accuracy with which the supervising authority may detect error or neglect on the part of plant operators. The record of plant performance through a wide range of previously selected degrees of equilibrium was included to exhibit the excellent effluent characteristics which may be consistently maintained under these wide variations in the process mechanism, and the ability of this process, when properly controlled, to accommodate the normal daily range of load variations at predetermined degrees of process equilibrium bordering on the danger zone.

It has been demonstrated that a properly instructed non-technical plant operator, with the aid of a few simple graphic charts or schedules and the centrifuge and blanket finder, can consistently maintain a high degree of clarification and purification. The procedure may be likened to navigating a ship. Given a blanket finder as his barometer, a centrifuge as his compass, and charts to plot his course, the operator will reach port safely, widely avoiding shoals, hurricanes or other menaces to navigation.

It is submitted that the practical results exhibited in the reported data provide impressive argument for the abandonment of tedious and time consuming laboratory procedure for control purposes, in favor of the adoption of the simple and reliable centrifuge and blanket finder. It has also been demonstrated that the cost per pound of B.O.D. removed in the process is substantially reduced by maintaining the process at equilibrium. This becomes an additional incentive for accurate and reliable process control.

Process Mechanism

Omitting a discussion of the continued study of the process mechanism during the succeeding years and the development and confirmation of the newly discovered theories and control measures described, it may be broadly stated that eremacausis is a principal factor in this process and that it is related in velocity to surface areas, and in view of the highly amphoteric character of the dissolved components, it is related to partial pressures and concentrations. Serious errors may be introduced in attempting to evaluate sludge solids by weight as a control factor. Slight inclusions of microscopic or macroscopic mineral particles will result in gravimetric values greatly out of proportion to the surface areas represented. The size and proportions of the container in which mixed liquor is settled will have a substantial bearing on the character and rate of sedimentation. As many operators have frequently observed, even specimens taken from the aeration tank at the same time in settling glasses of uniform proportions, and representing specimens and conditions identical in every respect, will frequently exhibit settled sludge volumes varying as much as 25%.

Fig. 9 illustrates the non-uniformity exhibited by sludge settling from mixed liquor in settling cylinders of varying proportions. From left to right, these cylinders are 100 ml., 250 ml., 500 ml., 1,000 ml. and 2,000 ml., standard laboratory cylinders, 1 litre "Settlometer." 2 litre "Standard Settlometer," 7 litre special "Settlometer," and a 16 litre cylinder, the grandfather of settling glasses, designed for special laboratory studies. As illustrated, the sludge volume settling from a uniform specimen of mixed liquor in thirty minutes, in the assorted settling glasses, varied from 224 cc/l to 380 cc/l. Taking the volume shown in the 1,000 ml. and 2,000 ml. "Settlometers" (235 cc/l) as a standard to be correlated with plant conditions, the cylinder values varied from 95% to 162% of the standard "Settlometer" value.

Undoubtedly, there are countless organisms in a group of processing tanks busily engaged in maintaining their life processes by consuming food materials in the raw sewage and each other. A reduction of unstable matter by bacteriolysis and enzymolysis is necessarily evident to some unknown degree.

The difficulties confronting anyone attempting to harness and direct this myriad of forces would seem to be insurmountable. A pilot plant demonstration of the performance of the aeration-sedimentation process under sterile conditions was conducted in the laboratories of the Fleishmann Yeast Company at Pekin, Ill., for four weeks in the summer of 1936. Previously formed "activated sludge" was sterilized by boiling for six hours. Daily additions of raw waste were similarly sterilized. No living animal inclusions could be detected by microscopic examination throughout the test.

The processing equipment and operating control was identical with that of a conventional cycle. The sludge was maintained in perfect operating condition throughout the period of test, and the effluent suspended solids concentration equaled the best results obtained in non-sterile tests. Obviously, no B.O.D. tests would exhibit relevant data.

The ability of a processing mechanism to perform its functions—the removal of suspended matters and the reduction and stabilization of dissolved matter, is dependent upon the maintenance of the mechanism in proper condition. The control measures reported herein are related to physical factors only.

The author does not feel competent to adjudicate controversies regarding the effective elements of the aeration-sedimentation process, being content to respect the facts disclosed. These facts have suggested the adoption of the term "Oxidized Sludge Process" as a more appropriate designation of this process than Activated Sludge.

Patent Situation

Practically every item of equipment in an activated sludge treatment plant is manufactured and sold under one or more patent rights. Nearly all apparatus bears a tag to this effect. This would include pumps, compressors, motors, chlorinators, chemical feeders, mechanical screens, mechanical grit chambers, mechanical aerators, clarifier and digestion tank mechanical equipment, and substantially every device advertised in the pages of this or any other high class publication. The sale price includes such royalties, or development expense write-off, as the manufacturer may find necessary to recover, during the life of the patent, 17 years, the costs of the improvements incorporated in the article.

Research, development and patent protection are generally very expensive items. Without them, progress and increased efficiencies would be greatly retarded.

Private corporations, to a greater extent than municipalities, demand the most reliable and most efficient equipment available, to insure the minimum of expense over a period of years. This confines purchases to patented articles since that, in itself, gives evidence that the manufacturer is a sound, business-like organization, devoting study and expense to the development of more efficient apparatus, processes and systems.

Failure to respect the patent laws of this country and to obtain proper license to the then existing "activated sludge process" patent rights, became a very expensive error to many municipalities some years ago. Modern complete treatment plants, purchased from manufacturers licensed under the apparatus patent rights associated with the control system rights referred to herein, are automatically granted a license to these process control rights. Separate licenses to process control patent rights are available at nominal expense only to municipal or private corporation owners of existing treatment plants.

Acknowledgment

In conclusion, it is fitting to express the author's sincere appreciation of the inspiration afforded by the persevering and unostentatious efforts of Wellington Donaldson. It is reasonable to expect that his work would have been crowned with equal success in the discovery and practical application of the basic factors involved, had his vocational pursuits permitted a continuation of his scientific explorations.

The considerably postponed publication of the theories and principles recited, and the results of the adoption of these principles in practice, may be regarded as largely due to three decades of training in reserving the results of study and research, until the principles involved can be fully developed and established beyond question.

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A Water Works Meeting Under the Elms

During sizzling July this novel and comfortable idea in the way of summer meetings was staged by the Association of Northwest Illinois Water Operators. The meeting, held at the Country Club of Canton, Ill., under the elms, was attended by 115. The view on the right shows State Sanitary Engineer Klassen and his picked "Jury of Experts" conducting the Question and Answer Hour. The jury consisted of Superintendents Delmar Riser (Bloomington), Wm. Anderson (Moline), Chester Miller (Canton) and, as foreman, Ralph Holtsclaw (Hamilton)—the latter being secretary of the association. All hands voted the out-door meeting a swell idea.—(*Snapshots by courtesy of John Harris of Industrial Chemical Sales, Chicago.*)

REDUCING THE COST OF SLUDGE REMOVAL

Experiences at Aurora, Ill., with a "Saddle-Bag" Tractor

By WALTER A. SPERRY,
Superintendent,
THE AURORA SANITARY DISTRICT,
AURORA, ILLINOIS

DURING the summer of 1940 the Aurora Sanitary District constructed eight new sludge drying beds under a W. P. A. contract. This increased the sludge drying area from 50,000 to 96,250 square feet, which gave 1.44 square feet per capita on the original design basis of 67,000 population and 1.96 square feet per capita on the basis of the present population of 49,000. This increase was desirable due to the frequency of winter cleans caused by increased loadings on the plant and the addition of secondary sludge to the digesters in 1937.

The Author

Sludge Removal Methods Evaluated

New drying bed construction involved the selection of a method for removing sludge. Two factors entered in. The first was the cost of trackage versus a more modern method of mechanical removal. The second revolved around the sponsor's credit in the W. P. A. set-up for the disposal of some 3,500 cubic yards of excavation. If contractor's equipment was hired to do this work it would cost more than if the sponsor had in hand dirt moving machinery where the only expense would be gasoline, motor oil and the operator's wages. This led to the consideration of abandoning tracks in all beds and substituting therefor the "saddle-bag" tractor originally planned by Mr. W. B. Walraven of Springfield, Ill., and described by him in an article, "A New Device for Handling Dried Sludge," in *Water Works and Sewerage* of February, 1934. General investigation indicated that this was, by far, the best device available. Some pressure was brought to bear to adopt a self propelling bucket elevator to pick the sludge from the beds and discharge it to a following truck. Also,

Aurora's "Saddle-Bag" Tractor Atop the Sludge Pile in Unloading Position

This picture shows in a striking manner the ability of this crawler type tractor to mount the sludge storage pile. The operator by manipulating the unloading cranks on the rear of the side bins has accurate control of the place and time of releasing the load. Especially advantageous is this scheme of handling sludge where storage space is as limited as at Aurora. In this picture the pile is roughly 10 ft. high.

The Tractor Being Loaded During a Winter Cleaning Operation
The hard, frozen sludge is first broken up by the "breaking gang," and thereafter easily loaded into the "saddle bags." Note the comfortable loading height of these side-bins.

it was urged to purchase a tractor with a yard shovel attachment in front, similarly working with a truck.

These devices were not suitable, first, because of the damage to the sludge beds in attempting to pick up mechanically a thin layer of material from a relatively thin layer of sand without disturbing the gravel underneath; second, because of the bulk of the equipment and the cutting up of the bed by both the tractor and truck; third, a truck was not suited to travel over the sludge storage pile; fourth, all of these devices were expensive and of no value for any other work about the plant; and, fifth, the required space for storage in the interim period was not available.

Advantages of the Crawling Tractor

The Springfield tractor, on the other hand, was self-contained. Equipped with caterpillar treads enabled it to travel over the sludge storage pile under quite adverse conditions, i.e., when wet and soft.

Due to its ability to mount and crawl over the storage pile, the "saddle-bag" tractor appeared to be especially useful in making the most of limited storage areas. It has also proved useful for the disposal of grit from the screen house to the storage space. The machine can be equipped with a bull-dozer for snow problems in the winter, for trimming the sludge pile and for grading gravel roads or pulling stumps. The tractor required small storage space and has generally offered all the facilities of a man carrying two buckets where the load could be transported and deposited anywhere the feet could walk.

Considering its adaptability and general usefulness, it seems surprising that but three of these machines are in use to date. The original one is at Springfield, the second at Mansfield, Ohio, and the third here at Aurora, Ill.

Trackage for the new beds would have cost in the neighborhood of three thousand dollars ($3,000). The tractor equipped with the side bins cost two thousand, two hundred and sixty dollars ($2,260). Against this cost its temporary use as a construction unit in building the sludge drying beds saved the Aurora Sanitary District about sixteen hundred dollars ($1,600) over rented equipment for the construction period.

The Unit

The tractor (see cuts) is an "M" type Allis-Chalmers caterpillar type machine. It is driven by a 32.4 H.P. engine with four forward speeds, is equipped with starter, and weighs 6,500 pounds. Equipped with the bins, it is about 8 feet long, 7 feet wide and 6 feet high over-all. The bins, which have a combined capacity of 3 cubic yards, add another 1,500 pounds, for a total weight of 8,000 pounds. It has a bearing of 1,530 square inches. With full bins this gives a pressure per square inch of from 7 to 9.5 pounds, depending upon the moisture content of the sludge. The bins are constructed of 8 gauge metal and the whole device is of such strong and sturdy construction that its life will be many years. The original machine purchased in 1932-33 is still in use at Springfield and in good order.

Performance Records

Before purchase of the tractor, in the period July, 1939, to May, 1940, inclusive, 4,055 cubic yards of sludge were removed from the Aurora beds to the storage pile at a total cost of $2,095.51, or 51.6c per cubic yard. The unit cost varied from 30.6c to 67.7c per cubic yard, as between summer and winter conditions. For this period the standard crew then hired for the cleaning job consisted of a team at $10 per day and seven men at 45 cents per hour. This gave us a daily hired labor cost of $35.20. Experience showed that three one cubic yard cars, two men to a car, gave the right balance of work for the team and Fresno scraper used.

The tractor was purchased and went into use in June, 1940. Between June, 1940, and March, 1941, inclusive, 4,933 cubic yards of sludge were removed to the pile at a total cost of $1,057.59, or 21.4c per cubic yard, to which should be added two cents per cubic yard for tractor oil and gasoline. The tractor crew consisted of four men at 45 cents per hour, or a total cost of $14.40 per day. This is a difference of $20.80 per day for

hired labor between the two methods. Note that the gang foreman in the first case is the tractor operator in the second case. He is a plant employe on the regular payroll and not included in either cost estimate. This indicates a saving of 54.8 per cent for the new method.

At the time the tractor was purchased it was assumed that the saving would be in the cost of the track and the reduced price due to the temporary rental to the Government, and that the time of sludge removal might be extended since but four men were lifting sludge against six with the old method. The interesting surprise was that four men and the tractor do at least 90 per cent as much work as six men, due to the fact that the trip to the storage pile is but once for every 3 cubic yards, whereas, formerly each 1 cubic yard lot was pushed by car to the pile by its two man crew, with "waits" for any car ahead to clear switches.

During interim periods the tractor is stored in the screen house and is used almost daily to remove grit. A bull-dozer blade is being planned for permanent mounting for clearing snow from the plant driveways, trimming the storage pile, and for maintenance of the gravel roadways.

Two Minor Objections Appear

Two minor objections to the tractor are that a little more care must be taken to keep the sludge beds well sanded against the disturbing effect of the tractor cleats. The second objection developed this winter when it was discovered that the physical condition of the operator was affected due to shock and jar caused by the frozen state of the ground. Happily this was satisfactorily corrected by the purchase and use of a wide leather belt such as is used by motorcyclists and truck drivers to support the abdominal region.

CHLORINE NOW ON PRIORITY LIST

Supply Assured for Sanitation, but May Mean Yellow Paper for W. W. & S.

ON JULY 26th liquid chlorine was placed on the priority list by the Office of Production Management.

In our issue for July, under heading "Ample Chlorine Supply Assured," it was stated that water and sewage authorities would be relieved to know that the O.P.M. had made a statement for publication, advising all concerned that a supply of chlorine for public health was assured. In the reproduced letter from Director of Priorities E. R. Stettinius, Jr., to Dr. Thomas Parran, Chief, U. S. Public Health Service, it was stated that chlorine needs for water and sewage purification and sanitation would receive "preferential treatment on a basis of equality with direct defense application."

In view of the closely following order of July 26 (No. M.-19) placing chlorine under priority control, the statement made by Director Stettinius was well timed to remove anxiety from water and sewage works managers and public health authorities.

On July 30th, Leon Henderson, Director of OPACS and Administrator of the O.P.M. order, in so far as allocation of chlorine to competing civilian demands is concerned, issued a preferential order which was published in the Federal Register of July 31st.

The Administrator's order to chlorine producers under "Allocation of materials," states—"Adequate supplies of chlorine shall be allocated for the following uses:

Water Purification
Sewage Treatment
Sanitation
Slime Control in Industrial Plants
Preparation of Medicinals
Preservation and Processing of Foods.

Under heading—"Avoidance of Excessive Inventories" the order states—"Preference granted under this program shall not be used to accumulate excessive inventories."

In our issue of July we made a plea that chlorine hoarding meant the tying up of containers which might result in container shortage, rather than a chlorine shortage, but amounting to the same thing. Now this O.P.M. order takes cognizance of the hazard of hoarding, by making it mandatory that excessive stocks of liquid chlorine shall not be built up.

Question of Paper Quality

While we are exceedingly happy that our readers will have nothing to worry about relative to their supply of chlorine for making the world "safer for the democrats," we as publishers have something else to think about. That is, the matter of paper stock on which WATER WORKS AND SEWERAGE is printed. Somebody will have to go shy of chlorine, and it looks like the paper manufacturers may be "It."

Our supplier of paper stock has already given us a note which informs us that paper of the high grade, which has heretofore been used in printing this magazine, may be unobtainable if the chlorine squeeze gets more severe. So, Mr. Reader, please remember that if before the year is out you receive a copy of WATER WORKS AND SEWERAGE that isn't printed on as nice paper as you now enjoy, it will be because it is a darned sight more important that you have the chlorine for water and sewage purification than that whiter paper be made on which to print such matters as this.

In the meantime *keep the empty containers rolling back to the producers.* It is obliged to help a lot in keeping chlorine rolling to others—and, to you.

SEWAGE TREATMENT ABROAD

A Digest of Selected Articles Appearing in Recent Issues of Foreign Publications

By C. E. KEEFER
Principle Ass't Sewerage Enigneer
BALTIMORE, MARYLAND

Sludge Conditioning. A unique method of conditioning sludge (*Proteous* process) at Halifax, England, prior to dewatering it in filter presses, is reported by Lumb. The sludge, which consists of approximately 5 parts of humus (digested) sludge to 1 part of activated sludge, is pumped through a heat exchanger into four steam heated vessels. Each vessel has a capacity of 1,800 gal., and is designed to treat 960 gal. of sludge per charge. Each batch of sludge is retained in the heating vessel for 1 hr. at a temperature of 360° F. The heated sludge is discharged into decanting and thickening tanks. From here the solids are pumped into 3 filter presses under pressure, where it is retained for 4 hrs. The pressed cake is further dewatered in an artificially heated drying shed. During a 10-month period the moisture content of the sludge was reduced from 94.7% to 89.3% by heat treating and thickening. The moisture of the cake from the filter press was 41.3%. During the last five months of the ten 0.56 lb. of steam was used to heat each gallon of sludge. The character of the liquor from the decantation tanks and the filters has been quite strong, having an average 5-day B.O.D. of 4,220 p.p.m. and containing 11,350 p.p.m. of total solids. The net cost of dewatering the sludge has amounted to 1 s. 3.2 d. per ton of raw sludge. The process is reported to be free from odour nuisance.—("The Surveyor"—London, Dec. 6, 1940.)

Sludge Digestion at Manchester, England. At Manchester a mixture of raw primary sludge and activated sludge is digested in four heated primary digestion tanks and two unheated secondary tanks. A summary of the operating results for the 2-year period from 1938-1940 is as follows:

Primary digestion tanks:	
Capacity of 4 tanks, cu. ft.	139,000
Temp. of digestion, deg. F.	80-85
Charging rate—days per week	6
Digestion period, days	12
Raw sludge added:	
Approximate composition—	
Primary sludge, per cent.	15-20
Activated sludge, per cent.	80-85
Dry solid content, per cent	3.2
Organic matter, (d.b.) per cent	66.4
pH	6.7
Amount added daily:	
Long tons	330
Lb./cu.ft. of tank capacity	0.17
Gas yield:	
Cu. ft./lb. dry organics/ added	3.4
Cu. ft./lb. dry organics/ destroyed	12.4
Secondary digestion tanks:	
Capacity of 2 tanks, cu. ft.	256,000
Digestion period, weeks (apprx.)	3
Supernatant liquor:	
B.O.D., p.p.m.	275
Total solids, per cent.	0.28
Suspended solids, per cent.	0.08
Digested sludge:	
Quantity per week, long tons	794
Solid content, per cent.	6.3
Organic matter (d.b.) per cent	59.2
pH	7.5
Reduction, sludge vol. per cent	66
Reduction, dry org. matter, per cent	34
Cost of digesting sludge, per long ton of raw sludge, has been	3.5d

(From "The Surveyor," London, Dec. 27, 1940.)

Production of Carbon Dioxide in Trickling Filters. Experiments conducted by Wilson and McLachlan on an experimental filter at Johannesburg, South Africa, indicate that carbonaceous matter in sewage is oxidized to a much greater extent in filter beds than by the activated-sludge process. The filters consisted of glass tubing 1⅜ in. in diameter and 5 ft. long, filled with graded pumice stone about ⅜ in. in size. The sewage applied to the filters first passed through coarse filter paper. As the result of 10 tests, the production of carbon dioxide varied from 8.5 to 48.2% of the total carbon input and from 11.5 to 61.2% of the organic carbon input.—(Annual Report of the City Engineer of Johannesburg—1940.)

Grease in Sewage and Sludge. At Munich, Germany, which is provided with coarse screens, grit chambers and two-story sedimentation tanks, the raw sewage contains 29.3 p.p.m. of grease and the effluent 15.9 p.p.m. The following gives facts regarding the grease in the raw sewage, the effluent and the sludge:

	Source of grease	Grease, grams per capita per day — Total	Saponifiable	Unsaponifiable	Percentage in raw sewage — Of total grease	Of saponifiable grease
1	Raw sewage	11.7	9.4	2.3	...	...
2	Floating grease	0.6	0.5	0.1	5.1	5.3
3	In raw sludge	4.8	3.7	1.1	41.1	39.4
4	Removed from sewage (2+3)	5.4	4.2	1.2	46.2	44.7
5	In effluent (1—2—3)	6.3	5.2	1.1	53.8	55.2
	In sludge:					
6	Digested sludge	2.6	1.4	1.2	22.1	14.9
7	Decomposed by digestion	2.3	2.3	...	19.0	24.5

About 80% of the grease in the raw sewage is saponifiable. Approximately 46% of the grease is removed from the sewage, only 5% of which is in the scum, and 54% remains in the effluent. It is estimated that 22% of the total sludge gas is produced by the grease, which amounts to 14.2% of the dry solids in the sludge. — (The Gesundheits — Ingenieur, Germany, Jan. 4, 1941.)

Control of Psychoda Flies. Laboratory experiments indicate that the Chironomids *Metriocnemus longitarsus* and *Spaniotoma minima* control the growth of *Psychoda* flies in trickling filters. These two species were found to destroy large numbers of eggs of other organisms and also those of their own species and during periods of food scarcity fed on larvae and worms. Chironomids in the fly stage did not feed but served as the egg-laying and distributive phase of the life cycle.—("The Surveyor"—London—Apr. 18, 1941.)

SUBMERGED COMBUSTION

Adopted for Recarbonation at Quincy, Ill.

By W. R. GELSTON, JR.
Superintendent
WATER DEPARTMENT
QUINCY, ILL.

and

E. W. DOUGLASS
Chemical Engineer
OZARK CHEMICAL CO.
TULSA, OKLA.

W. R. Gelston, Jr.

QUINCY, Illinois, located on the Mississippi River and about equidistant from St. Louis, Missouri, and from Davenport, Iowa, has been long a trading and an industrial city. Since its early days it has been progressive in thought and in action; a recent example of this spirit has been the installation of equipment to practice the submerged gas combustion method of recarbonating its water supply.

Quincy's water plant employs the conventional lime-softening treatment. The Mississippi River water is treated with sufficient lime to achieve a caustic akalinity of approximately zero to 50 p.p.m. As is well known, chemical reactions occurring in water softening through use of lime do not go rapidly to completion. Consequently lime-softened water is supersaturated usually with respect to calcium carbonate. As it tends to reach equilibrium after passing through the softening plant by precipitating the calcium carbonate representing the supersaturation, such water is incrustant, and precipitation may occur at any subsequent place in the distribution system. To prevent deposition of calcium carbonite scale, stabilization of lime-softened water has become common practice. Probably the best known and most widely used method of stabilization is recarbonation, which accomplishes the task by introducing carbon dioxide into the water to convert the relatively insoluble calcium carbonate into the soluble bicarbonate.

Frequently, the conventional recarbonation installation for the production of CO_2 gas and for its introduction into the water consists of a rather elaborate aggregation of gas burners, boiler, cooler, scrubber, compressor and grid system. The "Submerged Combustion" method for the same purpose is a radical simplification in that the fuel gas is burned in a burner submerged in the water to produce the CO_2 which is absorbed immediately as the water flows about and past the burner. Under-water gas burning was first applied in water recarbonation at the Water Treatment Plant of Oklahoma City, Okla., as described in the October, 1939, issue of this magazine by L. H. Scott, Sup't of Filtration at Oklahoma City, and F. C. Abbott, Chemical Engineer, with the Ozark Chemical Co. of Tulsa, Okla.

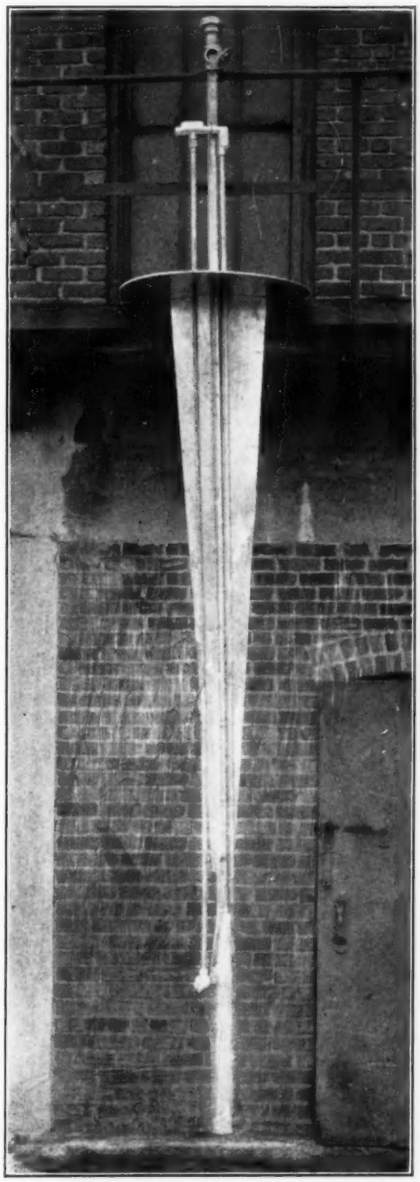


Fig. 1—Burner Assembly for Submerged Combustion

The burner at the lower end, which is submerged 8.5 ft. in service, is 3 ins. in diameter and 30 ins. long. Capacity of this unit is 2,330 lbs. of CO_2 per 24 hours, sufficient for recarbonation at a softening rate of 7.5 m.g.d. At the top of the down tube is the sight-glass for observing the blue under-water flame. A small sampling line draws combustion gas from the burner for analytical checking for completeness of combustion yielding 10.5% CO_2—see typical analysis figures.

For this novel development Mr. Scott was voted the George W. Fuller Award by the American Water Works Association. Experience with the Oklahoma City installation has resulted in improvements represented in the installation now to be described.

When this new method, together with its equipment, was given its first public demonstration by the Ozark Chemical Co. at the 1940 Kansas City Convention of the American Water Works Association, the late Mr. W. R. Gelston, Sr., then Superintendent of the Quincy Water Works, and father of one of the authors, became interested. After a careful examination of the process, and of its advantages, an installation was arranged for and put into operation March 4, 1941. At the date of this writing it has operated from 8 to 16 hours daily for three months. Aside from minor adjustments required during the starting of the equipment, no changes or repairs have been made. The new equipment replaced that of the conventional recarbonator mentioned above; however, this older equipment will be overhauled and held for service as a standby.

The city of Quincy uses normally an average of 3 m.g.d. of water. As the softening-and-filter plant can treat readily 7.5 m.g.d., and as the reservoir capacity is 19 m.g.d., the river pumping station and the treating plant are operated only about 10 hours per day. The economy of storage and plant capacity sufficient to permit one shift operation has been well demonstrated.

After the water has been treated with lime it passes to a Dorr clarifier and thence the clarified water passes to the recarbonation basin, which has a retention time of approximately 30 minutes. The water leaves this basin through collecting troughs along two sides of it. Egress from the primary clarifier is down a 4½ foot square vertical conduit, or well, 20 feet deep which connectes with a horizontal channel leading to the secondary settling basin.

Equipment for "Submerged Combustion"

The Submerged Combustion burner of the unit is located about 8½ feet below the water surface in the square down-flow conduit. In the burner assembly (Figure 1) the burner itself is 3 inches in diameter and 30 inches long. It is capable of burning efficiently sufficient gas for the recarbonation of the 7.5 m.g.d, and has a maximum productive capacity of 2,330 lb. CO_2 per twenty-four hours. The circular plate is bolted securely to the concrete floor directly over the down-flow well. The galvanized steel conduits, leading to the burner, carry the pyrometer leads which actuate the control and the alarm circuits, and the igniter line. The latter is a low voltage circuit. On the back of the burner assembly is a small line (not shown) through which samples of the burned gases can be drawn for purposes of analysis. At the top of the burner line is a sight glass through which the blue under-water flame may be observed when the burner is in operation. This novel sight is a focal point of interest (if not amazement) to plant visitors told that the flame is actually burning under 8 feet of water.

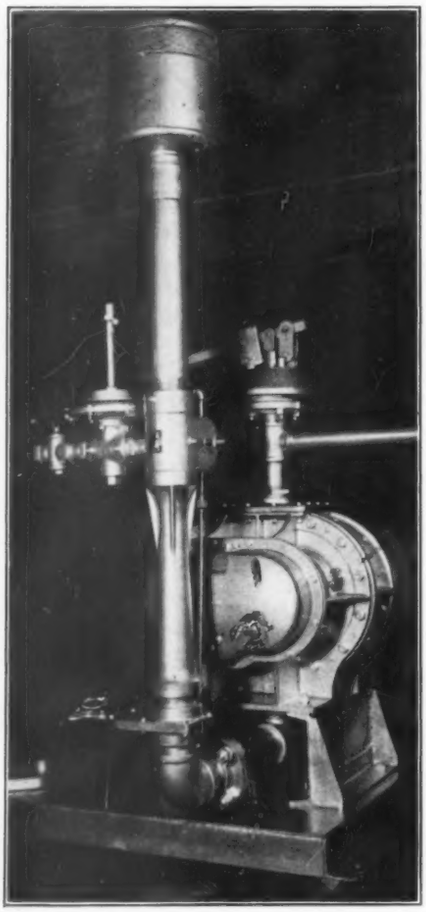


Fig. 2—Automatic Mixer and Compressor

Through the air-filter, the silencer and the venturi section air is sucked into the compressor serving as air-gas mixer and pump. Automatically the head differential through the venturi section admits gas at the predetermined correct air-gas ratio for perfect and complete combustion. Thus the single control of air intake automatically regulates gas intake and CO_2 production. The horizontal line, below the pressure relief valve above the compressor leads to the gas burner.

In Figure 2 is shown the compressor; the line extending to the right connects directly to the burner tee. Shown in the foreground are the air filter and silencer, the automatic gas-air proportioning unit and the blast gate. Immediately above the compressor is a pressure relief valve.

In Figure 3 appears the control panel that was installed in the chemical-feed room. At the top left is the pyrometer which is actuated by the thermocouple in the burner. In case of flame failure, the gas supply is cut off and an alarm is given. Below the pyrometer is the motor starter. In the center of the panel is the igniter switch and the pilot light; to the right is the gas-flow indicator. Just below the panel is the magnetic valve which prevents the flow of unburned gas into the water, should a flame failure occur.

The new recarbonator was installed and housed by the operating and maintenance men of the water plant. It was ready to operate on March 4th and was started and adjusted early in the afternoon of that day. The installation has been used daily since that time.

The unit purchased was to have a total variation in operating capacity of 30 per cent. Since the water plant operates at substantially a constant rate of 7.3 m.g.d. it was thought that this would be sufficient to care for the normal variation in CO_2 requirements. The actual operating conditions, however, have necessitated a burning rate of 8.86 to 13.6 cubic feet/min. of gas, or a variation of 35% from the maximum flow.

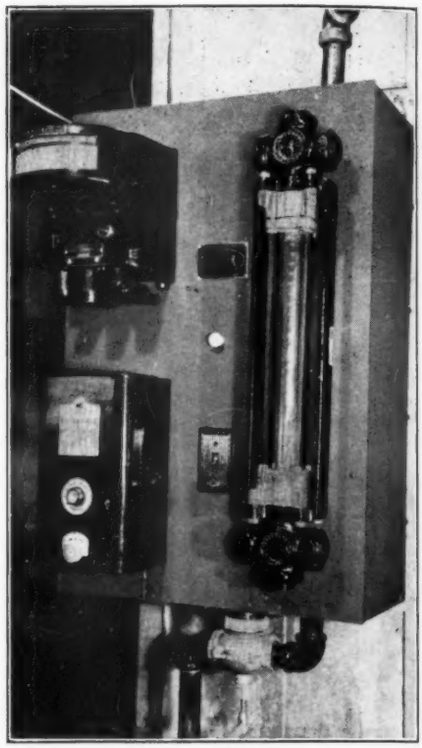


Fig. 3—The Compact Control Panel

Located in the chemical control room, it has a gas flow indicating meter of the "Rotameter" type (right); a pyrometer (above) actuated by a thermocouple in the burner chamber; an automatic gas shut-off valve (below) and alarm, which function in case of flame extinction. The igniter switch and pilot light are in the center, and starter for compressor motor is on lower left.

Performance Records

The composition of the burned gases delivered to the water were checked at the time of installation and after three months' operation by Orsat analyses, taken at the maximum, minimum and intermediate gas flows. The analysis shows the composition of these gases to be exceedingly uniform, and shows a very high concentration of CO_2 delivered to the water. Table 1 shows the maximum variation in constituents of the burned gases. The high percentage of CO_2 in the burned mixture is an important aid in securing good absorption.

TABLE 1
VARIATION IN COMPOSITION OF BURNED GASES
(% by Volume)

Constituent	Maximum	Minimum
CO_2	10.8%	10.4%
O_2	0.6%	0.4%
CO	0.0	0.0

The recarbonator has consistently converted 25 to 70 parts per million of $CaCO_3$ alkalinity from caustic or normal carbonate alkalinity to carbonate or bicarbonate. Table 2 illustrates the change in the water in passing through recarbonation chamber. It will be noticed that the water

before recarbonation was caustic, containing from 20 to 38 parts per million of causticity expressed as $CaCO_3$. After carbonation the water contained from —2 to 25 parts per million of calcium bicarbonate expressed as $CaCO_3$. By adding the hydroxide converted to the carbonate and the carbonate converted to the bicarbonate, we arrive at column 8 which represents the total change in the water in parts per million of $CaCO_3$, produced by CO_2 added by Submerged Combustion.

Since the unit has been in operation only three months it is, as yet, too early to make any definite predictions regarding maintenance. To date no repairs have been made and a recent inspection (June 6th) of the burner assembly shows no evidence of corrosion. A thin calcium carbonate scale has covered the surfaces immediately above the burner and below the water surface. It is possible that it will be advisable to remove this scale once or twice a year. This operation will probably require two or three hours' labor. The anticipated maintenance is therefore quite low.

TABLE 2
CHANGE IN WATER DUE TO RECARBONATION BY SUBMERGED COMBUSTION
(Data taken June 6, 1941; all figures in P.P.M.)

Time (P.M.)	Water Before Recarbonation — M. O. Alk.	Phenol. Alk.	Causticity (as $CaCO_3$)	Water After Recarbonation — M. O. Alk.	Phenol. Alk.	Bicarbonate (as $CaCO_3$)	Change** Due to CO_2
2:00	55	41	27	53	14	25	52
2:30	58	45	32	55	17	21	53
3:00	60	48	36	55	21	13	49
3:30	64	51	38	56	24	8	46
4:00	65	51	37	60	29	2	39
4:30	67	51	35	58	25	8	43
5:00	64	49	34	58	23	12	46
5:30	60	46	32	54	28	—2*	30
6:00	59	44	29	52	24	4	33
6:30	57	42	27	50	22	6	33
7:00	57	40	23	50	22	6	29
7:30	56	38	20	49	22	5	25
8:00	55	38	21	48	19	10	31
8:30	55	39	23	48	19	10	33
9:00	53	38	23	48	19	10	33

*This sample indicates 2 p.p.m. caustic alkalinity.
**Total conversion of $Ca(OH)_2$ to $CaCO_3$ and $CaCO_3$ to $Ca(HCO_3)_2$, expressed as p.p.m. $CaCO_3$ in each instance.

Taking the Sting Out of Water Bills

When consumers can be shown not only the causes of many of those "high" water bills, but also how bills can be reduced, the most belligerent complainants usually become mollified.

At the office of Will A. Hutchins, Sup't of the Freeport, Illinois, Water Department, customers see with their own eyes how tiny leaks—no greater than the drip from a faucet or a leaking toilet—represent a decidedly expensive waste during a month. They actually see how the water meter indicates even the smallest flow. Its construction is explained to them, and they clearly recognize the meter as an instrument of precision. They learn how they themselves can cut their water bills.

Equipment needed for Mr. Hutchins' demonstration is simple. He has set up in the lobby of his office a kitchen sink furnished with the devices illustrated. The regular kitchen faucet utilized, has immediately in back of it a union in which he inserts little orifice plates down to 1/64 inch. The orifices are drilled to give approximate rates of flow of ⅛, ¼, ½, ¾ and 2 gallons per minute, respectively. When the demonstrator opens the faucet wide, the customer invariably is astounded by the quantity of water passing through the small orifice.

To the left is mounted a rate of flow indicator which discharges directly into a one-quart fruit jar placed in the sink. On the office wall is an electric clock having a full sweep second hand, so that the customer can time the rates of flow into the fruit jar. The ⅝-inch water meter (with full sweep hand register) installed on the line supplying the faucet, of course measures and totalizes the volume of flow—indicating the progressive total amounts of faucet "leakage." A showcard above the exhibit graphically emphasizes the impressive monthly cost of even the smallest leak. Another meter is used to interest the customer in the internal construction and operation of a water meter.

Superintendent Hutchins' "high bill combatting" device apparently has more than justified its modest installation cost, in the case of Freeport; and the water departments of several other cities already have expressed their intention of adopting it.

"Results of Municipal Electric Systems"

Under this title the consulting engineering firm of Burns & McDonnell, of Kansas City, Mo., have just published their seventh edition (1941) of an electric rate book showing current operating records of earnings, output, rates, revenues, valuation, and other information as to the use and cost of electricity in 758 municipally-owned systems. The type of each plant and its management are recorded. In this respect it is of interest that the light and water systems are operated under the same management—the Sup't of Light and Water—in a great number of instances.

The volume of 428 pages is accompanied by interesting graphs and tables showing the rates and revenues, also facts pertaining to the increasing use of electricity and the decreasing cost of electricity in municipal installations.

City officials, operators, and managers of both private and municipal systems will find these operating records of much interest and value. Over half the systems in the country have lowered rates since the former 1939 edition. A majority of the cities have no bonded indebtedness on their municipal systems.

Every complete and authentic record received from municipal systems has been recorded. Therefore, it is a fair, unbiased cross-section of what muncipally owned systems are doing in the producing and selling of electricity from steam, diesel, and hydro plants.

The book may be obtained at a cost of $5.00, prepaid, from the authors, Burns & McDonnell Engineering Company, Kansas City, Mo.

"THAT AIR SNIFFER"

By D. R. TAYLOR
Plant Superintendent
ROANOKE WATER DEPARTMENT
ROANOKE, VIRGINIA

Dear Bill:

You are right in thinking that public relations do not start at the cashier's window. There are many opportunities for the consumer to form opinions about you, your organization, its policies and general attitude long before he finally reaches the cashier's window. As a matter of fact, by that time his ideas have probably become rather well crystallized, but I will give you my slant on this phase of operation in another letter some time.

Now getting back to your inquiry, you are right in suspecting that a deficiency or a total absence of air in the air chamber on the discharge of your piston pump may be causing the annoying dull pounding and an accentuation of its pulsations.

For goodness sake, don't spend a lot of money for an air compressor to eliminate this condition. The trouble can be corrected much more simply and inexpensively. Allow me the pleasure of presenting a gadget which we have devised for the alleviation of "pulsationitis" of our pumps. Due to the nature of its performance, we have named it the "sniffer." Please refer to the sketch that I am enclosing.

There is probably a plug or a drain pipe in the bottom of your pump casing. Install a ½ in. line (A) from this point to a point slightly above the top of the air chamber with a renewable seat globe valve (B) in this line. The length of a nipple below the top of it is a good location.

At the top of this line, install a tee (C) with the side outlet looking down, and after drilling and tapping the top of the air chamber, connect one end of this tee to the top of the chamber with another globe valve (E) and a check valve (D) between the tee and the chamber. This check should open for a flow toward the chamber.

At the other end of the tee, install a 6 in. nipple and another check valve (F), also set for a flow toward the chamber. Complete the line with a short nipple, a 90 degree elbow, and a length of ½ in. pipe dropping almost to the floor. This is done so that any drippings from this line will be near the floor and, therefore, will not bespatter your pump room and equipment.

"Doc"

Then purchase from your local mill supply dealer a gauge glass (GG) and install it on the side of the air chamber for an easy and quick determination at any time of the quantity of air in the chamber.

When the air needs replenishing, open valves (E) and (B) and the pump will do the trick automatically. On the up or suction stroke of the pump plunger, check valve (D) will remain closed, check valve (F) will open, of course, and air will be drawn into line (A). On the down stroke, check valve (F) will close and check valve (D) will open. The charge of trapped air will be forced into the air chamber.

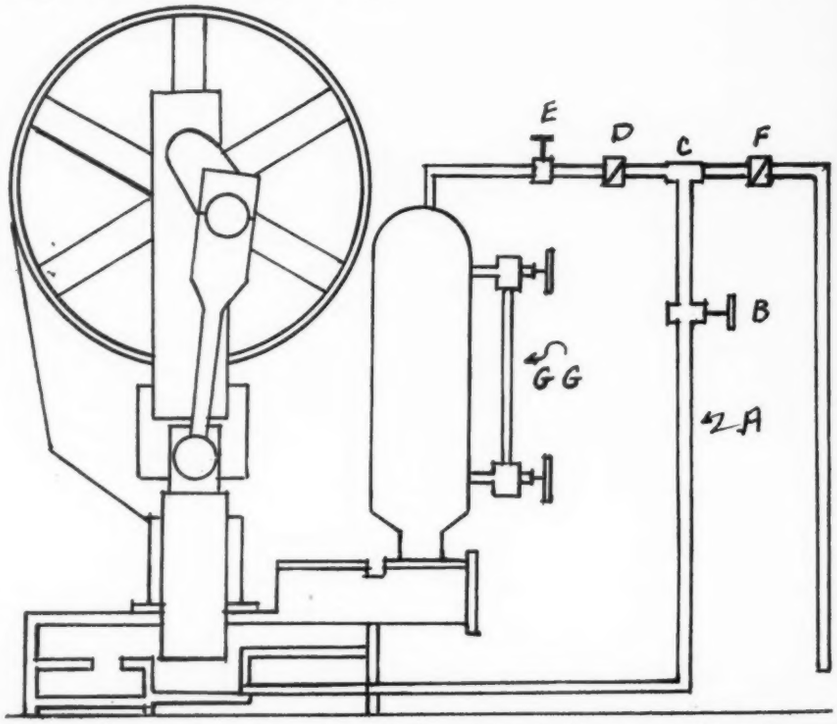
Let me warn you that this little gadget is much more vivacious than you might at first suspect. Only a few minutes are required to fill the chamber and, if the "sniffer" is allowed to operate too long at one "sitting," you may experience the contradistinctive annoyance of having too much air, possibly to the extent of aerating your transmission or distribution main. With a little experience, you will soon be able to determine the necessary frequency and length of time to operate the "sniffer" to satisfy your particular conditions, and then you can cross off another item from your headache list.

We have operated one of these gadgets on a five million gallon per day steam pump and one on a nine hundred thousand gallon per day motor driven triplex pump for a number of years with perfect success.

Well, William, the hour of retirement conducive to efficient performance by one of our vocation has long since passed, so, cheerio, until, I hope, soon.

Yours, etc.,

"Doc."



Sketch showing the method of installation of the "sniffer" on a triplex plunger pump.

THE COUNTRY'S FOUNDERS, in uniting the separate colonies into one great nation under the Constitution of the United States, formed a notable merger of resources and facilities for the greater benefit of the people . . . their industries and commerce.

It is to this historic pattern, expanding the advantages of those we are privileged to serve . . . that the Niagara Alkali Company and the Electro

"ORDAINED AND ESTABLISHED" FOR THOSE WE SERVE

"SIGNING OF THE CONSTITUTION," BY J. B. STERNS. REPRODUCED THROUGH COURTESY OF ROBERT FRIDENBERG GALLERY

Bleaching Gas Company, affiliated since 1915, now unite as one enterprise in the fields of chemical research and manufacture under the name of Niagara Alkali Company.

As the Niagara Alkali Company, we will endeavor to solidify our new greatness by continuing to maintain the ideals and high principles of product integrity that always identified our services, while expanding the scope of these efforts for greater usefulness to both our old customers and new friends.

Niagara
ALKALI COMPANY
60 EAST 42nd STREET, NEW YORK, N. Y.

CAUSTIC POTASH · CAUSTIC SODA
PARA · CARBONATE OF POTASH
Liquid Chlorine

EBG NIAGARA ALKALI

WATER TREATMENT AT THE A.W.W.A. CONVENTION

A Report on Sessions of the Water Purification Division at Toronto

By HARRY A. FABER*
Associate Editor
"WATER WORKS AND SEWERAGE"

This report, covering sessions of the Purification Division at the Toronto Convention, constitutes the second of three reports required to cover the 1941 *convention.*

The first, which ran in our July issue, covered the convention in general, and the special sessions on "Water Supply in Defense."

The third, which is to appear in September, will be devoted to covering the sessions of the Plant Management and the Finance and Accounting Divisions.

While we regret the necessity of stringing out the reports covering the Annual Conventions of A.W.W.A. between three issues, it is our wish to do justice to all speakers. This requires more space per issue, if divided between two issues only, than it is permissible to allocate at the expense of displacing other material.

THAT the Water Purification Division constitutes an important part of the A.W.W.A. was evidenced by the significant technical sessions which this division held during the Toronto convention. Members were given an opportunity to hear technical papers of more than usual interest and to participate in controversial discussions. But perhaps equally important, old friendships were renewed and valuable new acquaintances were made.

Purification sessions covered what might be termed "The Three R's"—one session being devoted to Research, one to Reports, and one to Revision. Every meeting was well attended, and the division luncheon was sold out to capacity, while tickets were still in great demand. Following this luncheon, members witnessed the showing of an unusual motion picture which disclosed the effect of wartime bombing on functioning of normal community life. Of particular interest was the illustration of methods which have been developed to combat these hazards and to maintain the operation of essential utilities.

1941 Chairmen Embryo

A picture taken long before either Chairman of the Purification Division had started their climb to head the Division. This snapshot of the retiring Chairman, Paul Weir (right), and his successor, "Matt" Braidech, was taken during the Cincinnati Convention in 1935.

Several papers presented in the general sessions likewise proved of particular interest to those interested in or responsible for water quality. The emergency disinfection methods employed in San Francisco and in Rochester during periods of pollution, the reports of committees on studies of the cross connection problem and on the quality and treatment of boiler waters; these are examples of closely related technical information.

Retiring Chairman Paul Weir, and all who cooperated with him to boost the Purification Division during the past year, deserve high praise for this program. The nominating committee, under Prof. A. P. Black, could have made no wiser or more popular selection than to choose for the coming year, "Matt" Braidech (Cleveland, Ohio), and Marsden Smith (Richmond, Va.), as Chairman and Vice-Chairman, respectively. With the fresh enthusiasm which these new officers will bring to their job, 1942 and the Chicago convention promises even greater progress for this Division.

Technical Papers

Research Is First

"Studies in Corrosion Control," by Henry P. Stockwell, Jr., Chemical Engineer, Water Purification Plant, Ottawa, Canada.

This comprehensive paper by Mr. Stockwell deserved the honor of beign first on the program. Corrosion is an important consideration at Ottawa, since coagulation of the Ottawa River water (high in color) results in a filtered water having a pH of only 5.5 to 6.0. As routine practice lime is added to produce a pH slightly above the $CaCO_3$ solubility point. Corrosion is suppressed by this treatment, but is not stopped. For that reason, tests reported on by Mr. Stockwell were devised in seeking a clearer conception of the problem and looking to the development of more effective control measures.

As the first step a laboratory study involving rather elaborate procedure was devised, based on the immersion of pipe samples in continuously flowing water. Six types of commonly used pipe materials (copper, brass, and four kinds of iron) were employed and the corrosion of both cold and hot waters was observed. Water was taken from the filter effluent line, treated, and conveyed by means of glass tubes through either a cold tank or through a thermostatically controlled hot tank. Applications of conditioning chemicals included lime, soda ash, and sodium silicate, which, with suitable raw and filtered control samples gave a total of ten types of water under study. All types of pipe were exposed to all conditions of treatment. Each test section was insulated to preclude the

*Research chemist, the Chlorine Institute, Inc.

possible development of galvanic action.

After periods of exposure varying from 60 to 792 days, test samples were removed for examination. Corrosion was measured both by loss of weight and by penetration, as shown with micrometer calipers. By means of slides, the effect of these ten types of treatment was shown in detail.

Brass and copper pipes gave evidence of least corrosion of all materials tested, while red water production was reduced in the several types of iron pipes. Though pipes gradually become coated with products of corrosion, no decrease in the rate of corrosion appeared to result. Sodium silicate treatment produced a thin, tough film. Treatment with chlorine and ammonia (3 to 1 ratio, 1.0 p.p.m. clorine dose) appeared to produce an even tougher film: no explanation being offered for this last observation.

M. C. Smith
Chief Engineer
Richmond, Va.
(New Vice-Chmn.)

H. P. Stockwell
Supt. Filtration
Ottawa, Canada
(His paper praised)

Present plant treatment with lime gives a reduction in corrosion of about 70 per cent, when compared with the original water supplied. Thus, since the required doses of other corrective chemicals are so much more costly, it had been concluded that the use of lime provides over all the most economical and efficient treatment. While copper or brass would cost five times the cheapest pipe studied (black iron) they would prove less expensive when rated on a corrosion basis. Comparative tests using sodium hexametaphosphate are planned to complete this study.

Edward S. Hopkins, Filtration Engineer, Baltimore, Md., pointed out that appreciable alkalinity must be present if corrosion is to be prevented. Careful studies indicate that about one part of calcium is required for each ten parts of iron. Likewise, deposition of coating below the equilibrium point provides only a porous and not a wholly protective film. In determining corrosion by weight of samples, the removal of oxidation products with inhibited acid has proven more accurate than washing of specimens.

John R. Bayliss, Physical Chemist, Bureau of Engineering, Chicago, Ill., praised the thorough study carried on by Mr. Stockwell, indicating that this work would be considered a classic in years to come. It offers new evidence that the problem of protecting a distribution system depends upon the protection of the protective coating deposited.

Robert Spurr Weston, Cons. Eng., Boston, Mass., observed that, in all cases of corrosion control, a distinction must be made between attaining results that are theoretically perfect and those which are "good enough to prevent ringing of the superintendent's doorbell." He cited instances in which changing the source of ground water supply and in which decomposition due to organic matter had caused destruction of protective coatings.

George D. Norcom, Cons. San. Eng. and Chemist, New York, also praised this paper, noting that it confirmed many ideas hitherto not proved. He regretted that only small service pipes and no large cast iron pipe had been studied, since the amount of tuberculation found would indicate the reduction in carrying capacity.

Col. T. H. Wiggins, Consulting Engr., New York City, closed the discussion of this important paper by giving an engineer's opinion that the "chemists' attitude toward this problem (corrosion) is one of defeatism." Citing the present control methods as at least partial solutions, he stressed the lack of standardized practice as deserving more attention. For example, there is as yet neither a cement specification nor a prevalently accepted cement-sand ratio demonstrated as best for pipe linings.

"Scientific Control and Critical Appraisal of Experimental Work," by John F. Norton, Director of Research, The Upjohn Co., Kalamazoo, Mich.

Mr. Norton preferred to title his paper, "What Should and What Should NOT Be Published." The wastebasket, rather than the editor, should be the recipient of much that is written on experimental work. This, because only when honest appraisal of experimental results indicate that new information is worthy of attention by others should a paper be prepared.

An individual with a natural curiosity is generally an asset to any organization; and, though few of us can be pioneers, many can follow up leads opened by others. Any problem may seem important to the one engaged in studying it, but in deciding whether or not the results should be published, the yardstick of "general interest" must be applied. Honest review of one's own work is difficult, because it is much easier to be merely logical with facts than to critically appraise them.

Vital points to be considered are: Is the data sufficient to satisfy criticism? Perhaps your hunch is wrong —could the data actually prove something else? Are the data, tabulations, and graphs so simple that they can be understood? Is the work reported so that it can be repeated by others? The author recommended a study of well written technical articles as examples of simple, clear, and direct presentation. If the experimental work passes the test of general applicability and the best possible presentation has been made, then draw only honest conclusions. By being his own severest critic, each author will find his work receiving a more welcome reception.

Gordon M. Fair
Prof. Sanitary Eng.
Harvard Univ.

John R. Baylis
Physical Chemist
Chicago

H. T. Hotchkiss, Supervising Chemist, Larchmont, N. Y., proposed that the program next year would benefit by a sequel to Mr. Morton's paper under the title, "How to Read a Scientific Paper."

"Viability and Destruction of the Cysts of Amoebic Dysentery," by Shih Lu Chang, M.D., graduate student, School of Engineering, and Gordon M. Fair, Prof. of Sanitary Engineering, Harvard University, Cambridge, Mass.

This report was presented by Prof. Fair, who credited Dr. Chang with having carried on much of the study described. Amoebic dysentery has as its causative organism, Endamoeba Histolytica which invades the intestinal mucosa. It is estimated that from 5 to 10 per cent of the U. S. population are carriers of this

disease. While normally growing in a vegetative form, spherical cysts are produced by carriers and are transmitted by sewage. Some results indicate a ratio of one cyst to 100,000 coli or organisms.

Research on amoebic dysentery is of importance because sporadic localized outbreaks due to cross connections have already occurred, and more and more frequently heavily polluted sources of raw water must be utilized. In this experimental study, survival of the organism under varied conditions of water temperature, pH, and chlorine dosage, was determined in literally thousands of culture experiments. Liver infusion agar was employed for development of cysts, as eosine staining methods were found to be an unreliable indication of kill.

A. P. Black
Prof. Chemistry
Univ. Florida

E.S. Hopkins
Engr. Filtration
Baltimore, Md.

The rate of death increases with increased temperature, and appears to be independent of water characteristics. Maximum time of survival of cysts was given as 90 days at 10° C.; 30 days at 20° C.; and 10 days at 30° C. Cysticidal chlorine doses demonstrate that these organisms follow the same death rate formula as other organisms, required doses varying inversely as the time of contact. A marked reduction in required chlorine dose occurs with reduction in temperature of the medium—some 40 per cent less chlorine being necessary at 0°C. than must be used at 10° C.

As would be expected from comparison with ordinary disinfection principles, the pH of the water has a marked effect on chlorine action. At low pH (under pH 6.0) a chlorine dose of 3.0 p.p.m. will be effective in 30 minutes, while at high pH (pH 9 and upwards) more than twice this dose is required. If ample reaction time is available, the dose can be reduced—for example, if 3 p.p.m. kills in 30 minutes, under the same conditions 2 p.p.m. will kill in 60 minutes and 1 p.p.m. will kill in 2 hours. Correlation of cysticidal chlorine doses with oxidation-potential measurements is now under way.

Water with negligible ammonia content was used in the studies, thus the doses of chlorine used remained in active form. Prof. Fair noted that the destruction of amoebic dysentery cysts appeared, from these results, to be well within the range of present superchlorination practice. While the experimental work is not concluded, these results are presented to give sanitary authorities a clearer conception of the possibilities of protecting potable water against amoebic infections.

In reply to a question by *John R. Baylis*, Prof. Fair explained that the cysts used were grown on culture media. Studies made by Baylis utilized cysts obtained from infected individuals, and the results of chlorine effectiveness did not appear to be so encouraging.

"Some Applications of a New Method of Determining Residual Chlorine," by Henry C. Marks and John R. Glass, Chemists, Research Department, Wallace & Tiernan Co., Inc., Newark, N. J.

In presenting this paper, Mr. Marks reviewed the disadvantages of chlorine determinations made by conventional methods. Electrometric equipment, for determination of oxidation-reduction potentials, represents a distinct improvement in chlorine measurement, and continued study has resulted in the latest method for this purpose.

This involves addition of a standard solution of sodium arsenite from a burette to the sample containing residual chlorine, while measuring electrical conductivity of the solution. The arsenite acts as a reducing solution to neutralize the chlorine and the end point is shown by the reading of a galvanometer. A variety of suitable electrodes have been investigated, with final selection being silver for the anode and gold for the cathode. Titration by this method measures the so-called "free" chlorine.

If, subsequent to this titration, potasium iodide is added to the same sample, then chlorine combined with ammonia can be determined. Typical titration curves were illustrated by means of slides, with particular reference to the application of this method to determine "breakpoint" doses of chlorine. Results obtained by this method are consistently slightly lower than those found by standard colorimetric methods. At present, it does not appear to be applicable if chlorine residuals are above 10 p.p.m.

Ferric and manganic compounds do not interfere with this test whether present either before or after addition of chlorine. Accuracy of the new method appears to be plus or minus 0.1 p.p.m.

Reports

Much duplication of effort in research problems or in surveys of practice can be saved through the work of committees. The reports which are submitted as a result of detailed study serve a very useful purpose and deserve careful review by those concerned with the special subjects. Eight committees presented reports at one session of the Purification Division:

E. H. Moore
Assoc. Professor
Harvard Univ.

Geo. D. Norcom
Engineer-Chemist
New York City

"Activated Carbon Research," by Chairman Mathew M. Braidech, Asso. Prof. of Industrial and Sanitary Chemistry, Case School of Applied Science, Cleveland, Ohio.

Earlier work of this committee was reviewed by Prof. Braidech, who noted that the laboratories of thirteen different observers have made some 4,000 threshold odor determinations. He commented on the three modified tests which have been developed, and reviewed the results obtained. The widely different results obtained by the various observers appear to depend upon individual odor sensitivity, as well as to vary from day to day. Thus the threshold odor still cannot be considered an absolute value.

Further progress has been made largely by work of individual committee members. Hulbert and Feben has demonstrated the influence of dilution on sensitivity; Helbig's work appears to implicate dilution water as largely responsible for wide variations; Spaulding has made certain improvements in technique. Recommendations of the committee are that: the present report should be made available to those interested and able to offer criticism, before final publication. Further individual research studies should be made and reported as a basis for future committee work.

"Specifications for, and Methods of Testing Zeolites," by Chairman Daniel E. Davis, The Chester Engineers, Pittsburgh, Pa.

The chairman's report was read by H. M. Olson, Chemist, Ohio Salt Co., Mt. Lebanon, Pa., who pointed out that this committee is working to establish a tentative set of procedures and then to standardize these. Several new members have been added in order to include those conversant with zeolite manufacture. Acceptable procedures for testing cation-exchange materials are being determined by means of a questionnaire. It is expected that further study will enable laboratory tests of physical and chemical properties to be correlated with plant operation.

"Chlorine-Ammonia Treatment," by Chairman F. Wellington Gilcreas, Asso. San. Chemist, State Dept. of Health, Albany, N. Y.

Mr. Gilcreas presented the summary and conclusions of a rather extensive report based both on a survey of plant practice and on a number of individual research studies. Further progress in the use of chlorine-ammonia treatment appears to be closely related to the results of broader present studies on the reactions of chlorine in superchlorination applications.

A list of those recommendations, which seem warranted by review of the data reported, includes: (1) That this treatment be used only when fitted to local conditions; (2) That the residual maintained for disinfection must ordinarily be at least twice that necessary with chlorine alone; (3) That a *minimum* contact period of two hours be provided; (4) That an effective chlorine residual can be maintained by this method. This report will be made generally available for review and comment.

"Methods of Determining Fluorides," by Chairman A. B. Black, Prof. of Chemistry, Univ. of Florida, Gainesville, Fla.

Prof. Black reviewed the salient points of earlier reports of this committee and presented this final report. Seven standard methods of fluoride determination, covering the range of 0 to 14 p.p.m., have been thoroughly checked. The precision of each of these methods has been proved to be practically the same. Simplest test, and that recommended by the committee, is the Scott modification of the Sanchis test. This involves use of only one reagent which reacts for one hour, after

J. K. Hoskins
Sr. Engr. USPHS
Washington

Paul Hansen
Cons. Engineer
Chicago

which the concentration of fluoride can be read directly.

Details of all tests will be reported, together with tabulations including the extensive work carried on by the committee. The ten individual laboratories cooperating in these studies as well as sixteen State Health Departments, which shipped a total of 0.7 ton of water over 900 miles, deserve unusual credit for this thoroughly conclusive piece of work.

"Standards for Purification Plant Operation," by Chairman Edward S. Hopkins, Filtration Engineer, Baltimore, Md.

Since this report covers in a specific phase every phase of chemical treatment, filter operation, and duties of plant personnel, any brief review would necessarily be very incomplete. Wording of the report in terms of "must," "shall," and other unequivocal designations, resulted in prompt objections by several members.

The enormous amount of information presented is worthy of critical study. Consequently, the executive committee has decided that copies of this report shall be made available for critical review and comment, and that the present committee will be continued in order to consider suggested revisions.

"Water Conditioning Methods to Inhibit Corrosion," by Chairman Edward W. Moore, Asst. Prof. of San. Chemistry, Harvard University, Cambridge, Mass.

Prof. Moore presented brief discussion as a progress report for this committee of which he assumed the chairmanship in 1940. In an attempt to secure comparable data on common methods of corrosion control, only limited data has been secured for treatment chemicals other than lime. For future study it appears that several more specific committees should be formed—for example, to investigate treatment methods for hot water, for nonpotable supplies, for slime growths, and the value of hexametaphosphates.

"Specifications for Filtering Material," by Chairman Paul Hansen, Consulting Engr., Chicago, Ill.

As a progress report, Mr. Hansen discussed the present understanding of the physical conditions affecting filtration of water through sand. Relation of filter sand size to length of filter runs, to coagulation, to back washings, and to other factors was indicated. Mention was made of old and new expressions for designating the desirability of sand. Latitude should be allowed in selection, as judgment must be based on water quality. In addition to study of anthracite and other filter media, the committee plans to study subjects on which there now exists insufficient data.

"Methods of Water Treatment and Laboratory Control," by Chairman George D. Norcom, Cons. San. Eng. and Chemist, New York, N. Y.

This committee has, for the third successive year, obtained data from the State Health Departments on intestinal outbreaks. Those reported during 1940 included 183 of gastroenteritis, of which 26 appeared to be definitely waterborne. In the majority of cases, these supplies contained coliform organisms, thus indicating likelihood of treatment failure. As in previous reports the mass of evidence supports the dependability of present standards, providing they are properly controlled and operated. While the committee believes sufficient statistics to have been obtained for the present, it was recommended that a close coordination with work of related organizations—such as the A.P.H.A. and A.M.A.—should be maintained.

Revision of Standards Proves Controversial Subject

One paper, describing the extensive investigation of water quality being conducted by Detroit, and a symposium including five scheduled speakers, made up an entire session of the Water Purification Division. A large attendance testified to the interest in this subject, while the diversity of opinions expressed was indicative of both active criticism and the cooperation which would be forthcoming.

"Investigating the Quality of Water in a City Distribution System," by William M. Wallace, Supt. of Filtration and Sewage Treatment, and Albert M. Shannon, Research Engineer, Department of Water Supply, Detroit, Mich.

The senior author, in presenting this report, stressed the fact that the ambitious program contemplated

Members of the Division Receiving the Geo. W. Fuller Award

Chester F. Drake
Supt., Purification
Pittsburgh, Pa.

August V. Graff
Supt., Purification
St. Louis, Mo.

John B. Harrington
State San. Engr.
Charleston W. Va.

Paul B. Laux
Supt., Purification
Anderson, Ind.

Walter L. Mallman
Mich. State College
East Lansing, Mich.

involves four main points: (1) What significance shall be attached to non-confirming gas formers? (2) Are there toxic chemical substances in the water which can affect the intestinal tract? (3) How can taste and odor materials best be eliminated from the distribution system? (4) Are present standards adequate?

To date, only the first subject has been attacked. The literature provides very little information on dysentery-causing organisms and usually the exact causative organism is not determined when epidemics of dysentery occur. However, it has been found that many soil types of micro-organisms exist in the Detroit raw water, pass through filters, and are not destroyed by ordinary chlorine doses. As these soil organisms die in the mains they accumulate as sludge, and, supposedly, provide suitable media for growth of other toxic or non-toxic organisms which later reach the sludge. Regular sampling of dead ends of various pipe sizes is carried out every two weeks, plating of samples being done on standard agar, tryptose gulcose agar, and in media for coliform identification.

A definite correlation has been found to exist between higher counts and higher water temperatures. Certain species of the salmonella organisms have been isolated, which seem to be implicated in cases of dysentery, and altogether 137 species of soil organisms have been kept for further study. Complete identification of organisms found and a study of intestinal pathogens is planned as this study is continued.

Expressions of great general interest in, and need for, investigations of the nature of the Detroit studies were forthcoming when Mr. Wallace concluded. Several members complimented the authors and the city of Detroit on the pioneer work which has been undertaken. It was mentioned that studies of

Geo. R. Spalding
Supt., Purification
Hackensack, N. J.

Chas. H. Spaulding
Supt., Purification
Springfield, Ill.

this nature are seriously needed in order to develop proper technique of broader bacteriological investigations than can be made with ordinary routine examinations. That the larger purification plants should devote a certain proportion of their revenue to such research was suggested.

"On Revising U. S. Standards for Drinking Water Quality,"—a symposium.

The logical opening discussion of this topic was *J. K. Hoskins*, Sr. San. Eng., U. S. Public Health Service, Washington, D. C.

Mr. Hoskins stated that because of a rather general insistence that the U. S. Treasury Standards for Drinking Water Quality are in need of revision, there had been appointed an advisory committee comprised of representatives of all technical associations which are concerned with such a step. A sub-committee has already made a preliminary report with reference to modifying the bacteriological scoring technique, rather than making standards more stringent.

Larger volumes of water in portions examined appear desirable in order to indicate lowest coliform indices. Daily samples should be taken, but averages over one month should meet requirements. Limitations of coliform density in water as it is applied to filters is considered, and it is contemplated that attention should be given to samples taken from distribution systems.

New standards will finally be drafted after members of the advisory committee have received the views of those they represent, and cooperation of the entire water works profession was requested by Mr. Hoskins—who also pledged that of the U. S. Public Health Service to this important work.

Charles R. Cox, Chief, Bureau of Water Supply, Department of Health, Albany, N. Y.

In general, Mr. Cox stressed the necessity for making the new standards flexible rather than specific. Scoring of water supplies in New York State has been found most accurate when taking cognizance of intangible factors, personnel, etc. Prechlorination has limited the significance of raw water coliform content, but there is recent evidence that false confidence has been placed in low chlorine residuals.

He proposed increasing the number of 10 ml. samples rather than increasing the size of each sample to 100 ml., in order to identify a bacterial density as low as one per 100 ml. Too much reliance has been placed on the practice of testing only finished water leaving the treatment plant, rather than also testing that water reaching consumers. New standards can apparently well utilize a code of recommended practice regarding plant operation.

Discussing the function of Federal and State governmental power, Mr. Cox indicated that water quality under the present system of State enforcement is sufficiently high as to warrant no extension of Federal regulation.

George D. Norcom, Cons. San. Eng. and Chemist, New York, N. Y.

The Treasury Department Standards for quality of drinking water on common carriers will, in Mr. Norcom's opinion, eventually become generally adopted and be made national in scope. Thus, it is fitting

that the present revision should include recognition of progress made since 1925 and should be based on present facilities of plant operation. Cases exist in which waters meeting present standards have been suspected of causing disease, but there always has been a questionable sampling procedure or some failure in operation which prevents implication of the standard itself.

While an increasing number of laboratories have utilized 100 ml. samples during the past few years, Mr. Norcom does not believe the results show a difference in sanitary quality. There is, however, more reason to require greater frequency and representative distribution of sampling—this being an admitted weakness which should be corrected. Two other important considerations should be included in designing revised standards: (1) That such revisions should be as practical for small purification plants as for the large ones; (2) That they should be based on scientifically developed facts rather than on empirical opinions.

John R. Baylis, *Physical Chemist, Bureau of Engineering, Chicago, Ill.

Standards of quality should be set by Public Health officials, said Mr. Baylis, and plant operators should have the fulfilment of meeting high standards as their aim. He believes the present standard, based on identification of non-pathogenic organisms, is too low. It appears that the present standard permits spread of pathogenic organisms by water, and that it fails to stimulate greater excellence in operation.

The meeting of high standards of bacteriological quality and of plant operation does cost money, but the prevention of disease can be measured in money, too, and Mr. Baylis believes the public can profit by paying for the necessary degree of treatment. He has stressed improvements in bacteriological quality, and has proposed a system of grading, in several published papers. On the basis of his proposals, a considerable number of plant operators were interviewed with the following division of opinion: 25 per cent of the operators believe his "grade A" water would be too expensive; 50 per cent already are producing water of this quality, or could with little difficulty do so; 25 per cent could meet such a standard with increase in cost of chlorination. The standards proposed by the committee should be especially extensive in the bacteriological section.

Abel Wolman, Prof. of Sanitary Engineering, Johns Hopkins University, Baltimore, Md.

The revision of standards, Prof. Wolman pointed out, must consist of two tasks: (1) To determine the underlying philosophy of water quality; (2) To adjust contesting points of view. For this reason, only an empirical standard is possible, and there is no suitable index for universal application.

Every standard ever used represents the conditions under which it was developed, and much improvement has taken place since introduction of the 1925 standards. It was re-emphasized that new standards must be sufficiently flexible to permit future progress in quality. There was no implication in the original standards that a "most probable number of 1.1" was set as the goal. If this cannot be determined except through the use of 100 ml. portions, it is not sufficient to condemn present tests.

A division of opinion on this controversial subject was indicated by the discussion following this symposium. Much objection to the use of samples larger than 10 ml. was apparent, both because of available equipment and because of inadequate evidence that the larger portion can be justified on fact. It was evident that the criticism as well as the cooperation of the water works profession, requested by Mr. Hoskins, will be forthcoming in ample degree.

*Associate Editor, *Water Works & Sewerage.*

A Correction

In our report covering the Toronto Convention of A.W.W.A. on page 299 of our July issue we credited Past-President Eugene Dugger (Newport News, Va.) as being chairman of the General Policy Committee of the Association. This was erroneous.

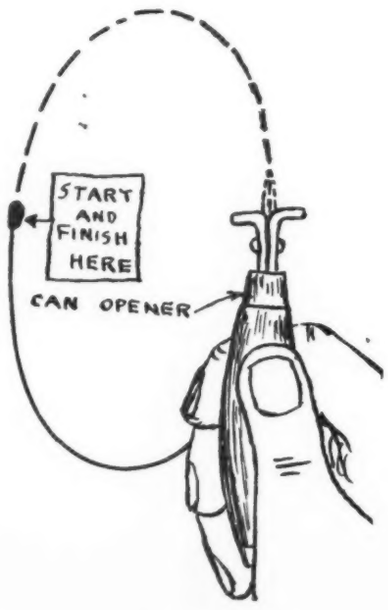
Mr. Dugger should have been credited with chairmanship of the Convention Place Committee. Past-President Arthur Jensen (Minneapolis) was chairman of the General Policy Committee, of which Mr. Dugger was chairman before Mr. Jensen. This fact accounts for the confusion.

Metal Cutting Kink

Here is a handy kink for the water supply and sewerage operators which I recently happened onto and have used successfully—the use of an ordinary can opener for cutting openings in sheet metal, openings of any shape, and even for cutting sheet metal in two.

I find that for certain purposes a sharp can opener is far superior to a pair of metal shears, chisel, or other methods commonly used.

The objection to shears is the interference of the metal to the working hand and the fact that the metal must be bent away to some extent in order that the shears can be put through. A can opener does not present any such interference difficulties and as a result both parts of the sheet metal—the part cut away and the part remaining—do not become bent.



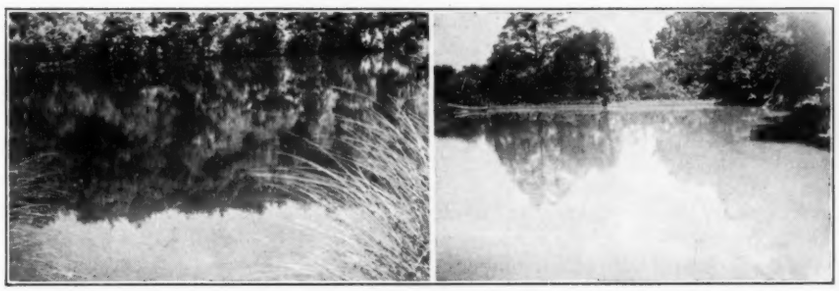
Simply punch a hole with the point of the can opener, as indicated on the sketch and just as you do when opening a can, and proceed. In the sketch the solid line is the portion cut and the dotted line is the uncut portion. To cut out an ellipse, circle, or another shape with a good sharp can opener becomes a very simple matter.

[Contributed by W. F. Schaphorst, M.E., Newark, N. J.]

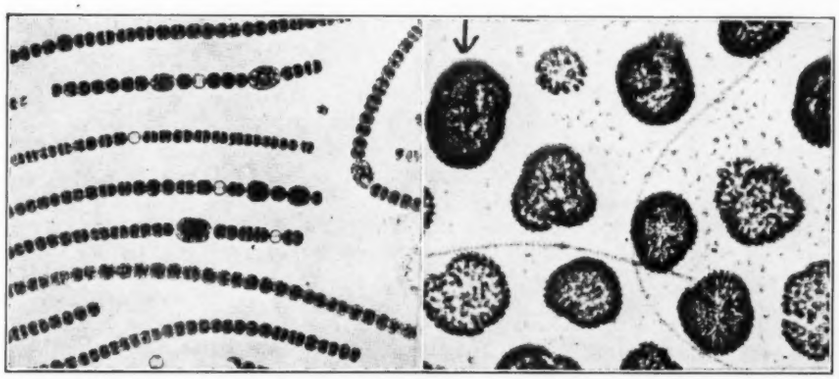
MIRROR LAKE TO MUDDY POND

A Short Story, Mostly in Pictures

By T. M. RIDDICK,
Consulting Engineer Chemist,
NEW YORK, N. Y.



A Mirror Lake (pH 6.8; DO 8.4) Becomes a Muddy Pond (ph9.; DO zero)



The Cause
Anabaena 8000 S.A.U. (left); Coelosphaerium 2000 S.A.U. (right)

THIS story can mostly be told in pictures which reveal a mirror lake turned into a muddy pond by algae growths which in the end were responsible for a sizeable kill of fish.

I was recently called in by an estate on which three small lakes were being used as gold-fish ponds. One of these lakes had gone "sour" as evidenced by the two photographs.

A microscopic analysis revealed the cause to be a growth of 8,000 standard areal units of Anabaena and 2,000 units of Coelosphaerium. A few fish at the time already showed signs of having the tummy-ache or worse.

The Effect
"Pea-soup" and Dead Gold Fish

After warning the owner that a fairly high number of fish deaths was inevitable, 0.5 p.p.m. of copper-sulphate was applied. The Coelosphaerium began to disintegrate immediately and the Anabaena was pretty hard hit, causing them to rise to the surface as a bluish-green flocculent scum. Decay of the algae depleted the dissolved oxygen and resulted in a sizeable kill of fish.

It was thought that gill clogging might have been the cause of death, but an autopsy failed to reveal anything other than the disappearance of oxygen.

BASIC FACTORS AFFECTING THE POLLUTION OF SUB-SURFACE WATER

By L. C. MacMURRAY
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THE problems involved in the pollution of sub-surface water frequently present many difficulties to the field worker engaged in the estimation of the effect of a focus of pollution on a water supply derived from underground sources. Much confusion exists due to too general acceptance of certain pseudo-scientific myths relating to the flow of sub-surface waters and the capacity of soils for ridding those waters of pollutants. The justification for this discussion lies in a desire to abate some of the misunderstanding of the subject by presenting certain of the fundamental physical and biological principles involved, together with a few elementary concepts of ground water hydrology; and to underline the conclusions reached with the results of specific experimentation.

Mountin[1] calls attention to the low position accorded the routine sanitation activities of health departments, ascribing it, in part, to the lack of application of the biological principles upon which sanitation should be based. This observation might well have been extended to include not only biological but physical principles. Thus, ground water pollution is limited not only by the environmental conditions affecting bacterial metabolism but also by the physical laws governing the movement of water through capillary channels. In amplification, the slope of the time-concentration curve is influenced by temperature, moisture, pH and food supply, while the movement of ground water is influenced by the permeability of the soil and the slope of the hydraulic gradient. An understanding of these and other basic principles is essential to the successful interpretation of field observations and analytical data collected in relation to a specific problem.

Basic Concepts and Terminology

Water precipitated in the form of rain or snow either runs off the ground surface into streams or lakes, becoming surface water, or enters the ground to become sub-surface water. That portion entering the ground is affected by a variety of physical forces. Its downward travel is impelled by the force of gravity, modified by the permeability and absorption characteristics of the soil and withdrawals by vegetation at the surface. If the force of gravity controls the movement, the water passes downward until it reaches an impervious stratum through which it can not pass. The impervious stratum may be clay, compacted and cemented sandstone or metamorphic and igneous rocks underlying the loose, uncompacted surface deposits. Through such a stratum there is either no vertical movement of water or the movement is so imperceptible as to be negligible. The downward travel of the water is halted by this barrier and the continued arrival of increments of water results in the filling of the interstices between the individual grains and saturation of the overlying material. The extent of this saturation is dependent upon the amount of precipitation and the discharge of water from this zone of saturation[2] through springs, lakes and rivers, so that complete saturation of the soil between the ground surface and the underlying impervious stratum seldom occurs. The upper surface of the zone of saturation is called the water table. Above it exists a zone of under-saturation or aeration where the interstices are only partially filled with water. However, all of the water entering the zone of aeration from the surface does not pass through it into the zone of saturation, since some is retained by surface forces of attraction at the boundaries between the solid material and the particles of water. Furthermore, immediately above the water table some water is held against the force of gravity by capillarity in a "capillary fringe." Figure I shows the relative positions of these various zones.

Within the zone of saturation, the movement of the water is still influenced by gravity but it is further modified by the slope of the underlying impervious stratum. The movement in general will be influenced by the slope of the inclined surface of the impervious stratum and toward a point of ultimate discharge such as a spring or stream bed where the water table intersects the ground surface. The difference in elevation between the maximum elevation of the water table and the point of discharge will establish an hydraulic gradient similar to that established by a pipe or other conduit. If at some distant point the moving ground water passes under an impervious stratum, a pressure may be built up within the confined water resulting in artesian flows when the water-bearing stratum is tapped by wells.

In addition to the slope of the hydraulic gradient, percolation, or the rate of movement of ground water, is dependent on the permeability of the soil or the rate at which water will pass through it. This, in turn, is influenced by the porosity of the soil, i.e., its property of containing interstices. The diameter, arrangement and interconnection of these interstices have an important bearing on the permeability of the soil. In heterogeneous material the finest interstitial material which occurs in sufficient amounts to surround the grains of coarser material controls the rate of percolation.[3]

The specific rates of percolation for many materials have been measured. Tolman[3] presents the following average field velocities in feet per day in natural granular materials:

Type of Material	Grain Size in mm.	Average field velocities in feet per day when the hydraulic gradient is: 1%	100%
Silt, fine sand, loess	0.005— 0.25	0.065	6.5
Sandstone, medium sand	0.25 — 0.50	1.16	116.0
Coarse sand, sandy gravel	0.50 — 2.0	6.33	633.0
Gravel	2.0 —10.0	30.0	3,000.0

Tolman also directs attention to the fact that normal ground water gradients seldom exceed one per cent.

The rates of percolation given above are below the critical velocities separating turbulent flow from

laminar flow. We may predict from this that in ground water flow there is no fluctuation in the position of individual particles of water from the top to the bottom of the water-bearing stratum, but rather that each particle tends to move in relation to other particles according to their relative specific gravities and the hydrostatic pressure exerted on each.

With these elementary concepts of sub-surface hydrology in mind, we are now in a position to investigate certain biological principles relating to the metabolic activity of bacteria under unfavorable environmental conditions.

History and Survival of Bacteria

The primary danger involved in the drinking of water either from surface or sub-surface sources arises from the possibility of contracting a disease following the ingestion of certain pathogenic bacteria. These include members of the genera *Salmonella* (Salmonella paratyphi), *Eberthella* (Eberthella typhosa) and *Shigella* (Shigella dysenteriae), which bear a close relationship to the genus Escherichia, whose normal habitat is the intestines of mammals. These latter, Escherichia, constitute a portion of that group, which with members of the genus Aerobacter, was formerly referred to as the "B. coli" or "coli-aerogenes" group, and more recently the "coliform group."

It obtains that if the normal habitat of these organisms is the intestines of mammals and one mode of transmission of the specific diseases is by drinking water, then conditions must be such that the organisms enter the water, are carried to a point where the water is withdrawn for domestic consumption and survive in sufficient numbers to produce a clinically recognizable manifestation of the disease. The accepted procedure among sanitarians is to utilize the coliform organisms which are normally present in all fecal discharges as indices of pollution rather than specific pathogenic bacteria which would be absent except in the case of illness amongst those contributing to the source of pollution. The expectancy is that if typhoid or dysentery patients or carriers contribute excreta to a focus of pollution, this specific pathogenic organism will pass through the same channels as the coliform organisms discharged by well persons and thus affect the water supply. Fortunately, the culture of the coliform bacteria presents less technical difficulties than the culture of the related pathogens. If a slight error exists in this hypothesis, it is that the pathogens are usually somewhat less resistant in an unfavorable environment than the coliform organisms, and hence the application of the hypothesis in practice generally results in increased safety.

Continuity of a favorable environment plays an important role in the viability of all bacteria and in particular those which are non-sporing, as are all members of these groups. Thus, changes in temperature, pH, moisture, food supply and other environmental factors have a marked effect upon the bacteria, and when the changes are severe, induce rapid death. However, the time-concentration curve follows a modified logarithmic curve so that even after a relatively long period of time the more resistant individuals survive. The contrast between conditions surrounding life in the intestinal tract where there exists a constant temperature and pH and an abundance of food and those outside of the intestinal tract at substantially lowered temperature, altered pH and a scarcity of food serves to rapidly diminish the number of organisms. Obviously, if the time interval between the source of pollution and the use of the water is sufficiently long, the chance for survival of any individuals is almost negligible. Therefore, aside from other factors, a lengthening of the time interval adversely affects the opportunities for survival of the organism.

In addition to these environmental factors related to their own metabolism, the bacteria must overcome a number of natural physical obstacles. These obstacles include the natural retention of bacteria in the soil by filtration, resulting from adsorption

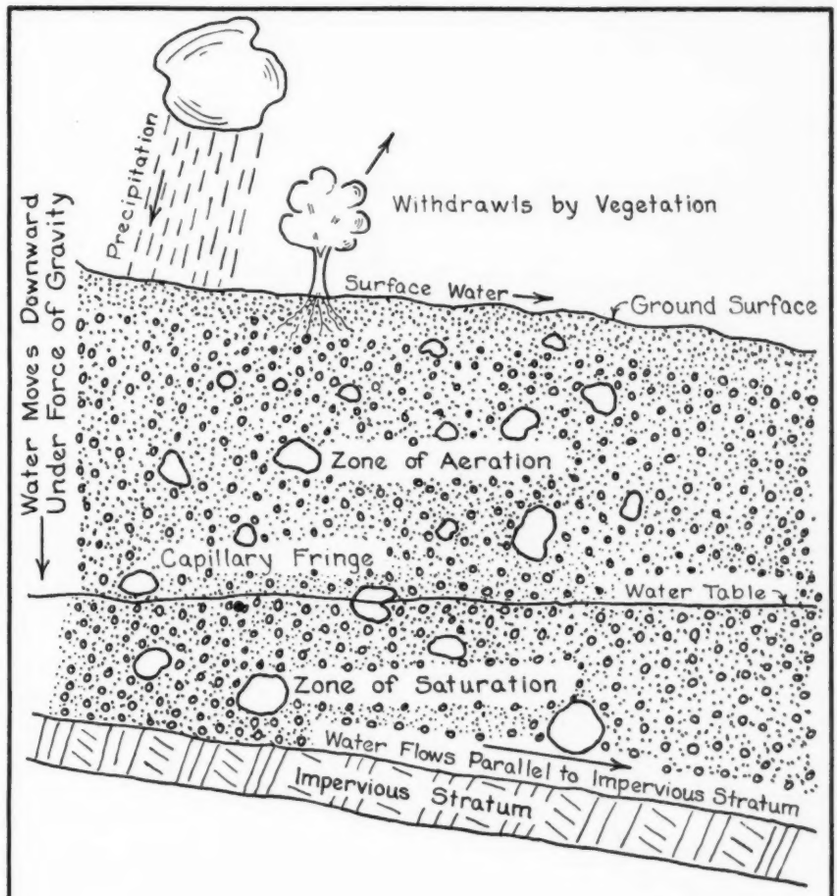

FIGURE-I
RELATIVE POSITIONS OF ZONES OF AERATION AND SATURATION
AND
TRAVEL OF SUB-SURFACE WATER

and sedimentation; clogging of the interstices between the grains as filtration proceeds; and the rise and fall of the ground water.

It may be said, further, that many of the conditions surrounding ground-water flow influence the travel of bacterial pollution in a direct relation to the effect which those conditions exert on the metabolism of the bacteria. The relatively slow movement of ground-water extends the position on the time-concentration curve to the right within relatively short distances from the focus of pollution; the laminar nature of the flow tends to concentrate the bacteria near the capillary fringe into which they are withdrawn when the water-table is lowered; the impermeability of certain strata prevents the passage of bacteria altogether. It may be reasoned that if feces are deposited on the surface of the ground or in the zone of aeration, the rate of downward movement toward the zone of saturation would be slight unless there were sufficient precipitation to cause a positive movement of water through this zone. The experimental data confirm this hypothesis and also the corollary that bacteria reaching the zone of saturation will not survive for indefinite periods of time and that the extent of the pollution will first proceed to a maximum and then recede as clogging fills more and more of the pore space.

Experimentation has been directed toward measuring quantitatively the extent of sub-surface pollution, both bacterial and chemical, in direction, distance and intensity. Most work has been limited to investigation of the travel of pollution in uncompacted strata near the surface where the flow is in capillary channels. It is from these strata that shallow wells derive their water.

A significant contribution to the more recent attempts to evaluate the problem was made by Kliger.[4] The viability of organisms exposed to an unnatural environment was investigated and the results may be summarized as follows from the author's conclusions:

1. Both typhoid and dysentery bacilla succumb rapidly on an exposure to an unnatural environment.
2. In solid feces, typhoid survives from ten to fifteen days, while dysentery is less resistant and paratyphoid more so.
3. In moist natural soils the typhoid and dysentery bacilli may be recovered up to seventy days; in the same soil dry, not after two weeks.
4. Moisture and reaction of the soil are the major factors in survival, while temperature has a lesser effect.
5. Certain soil bacteria exhibit an antagonistic action on typhoid and dysentery bacilla due to the alkaline reaction resulting from their metabolism or as in the case of *B. fluorescens* (Pseudomonas fluorescens) and *B. proteus* (Proteus vulgaris) due to specific inhibitive substances elaborated.

He also concluded that ". . . in moderately compact clay and sand, clay or sandy soil, free from cracks, the possibility of sub-soil pollution of the ground water is negligible, provided the ground water level is more than 10 feet below the polluted area."

In 1923 Stiles and Crohurst[5] reported the results of extensive experiments in which the pollution of ground water was correlated with the rise and fall of the ground water table, the flow of ground water and the rainfall. The significant facts developed from these studies were confirmed by later studies by the same men in collaboration with Thomas[6] and the recent work of Caldwell.[7,8]

Stiles and Crohurst[5] state that the results of 27 weeks' experiment showed that:

1. Pollution traveled only in the direction of flow of the ground water.
2. Pollution from fecal B. coli (Escherichia coli) traveled 65 feet from the point at which the pollution was introduced, while chemical pollution (uranin) traveled 115 feet. The sand had an effective size of 0.13 mm.
3. The pollution traveled in a thin sheet at the surface of the zone of saturation. There was no evidence that it dispersed radially downward.
4. As the ground water table fell, the pollution tended to remain in the new capillary fringe.
5. There was no evidence to justify a conclusion that either bacteria or uranin was carried or moved an appreciable distance in the capillary fringe.
6. A rise in the ground water table sufficient to re-establish the zone of saturation resulted in the bacteria being picked up and carried along.
7. The ultimate distance to which the pollution will be carried is dependent on weather conditions resulting in the rise and fall of the ground water table, the rate of ground water flow and the viability of the organisms under conditions of moisture, pH, food supply, etc.

After a period of 2 years, 8 months,[6] the bacteria pollution (*B. coli*) had been recovered at a maximum distance of 232 feet and the chemical pollution (uranin) at 450 feet.

The more recent observations of Caldwell[7,8] should be mentioned. It was found that the chemical pollution from a pit to which excreta was added daily described a path into the ground water, which was the "resultant of the interacting forces of lineal flow with the ground water toward the discharge stream and variations in densities of the effluent flow in comparison to the ground water." Chemical pollution (by analysis) extended through 310 feet. The bacterial stream (*B. coli*) formed an inner core which advanced only slightly beyond 10 feet, after which regression took place. She concludes that the limitation of pollution was due "'to defense,' clogging of pore spaces of the soil with fine fecal particles and aggregates of colloids and of organisms, which, in addition to the accumulation of sludge, retards flow and hence increases the time for the death rate of fecal organisms to operate."

The experimentation of these workers has provided a quantitative measure of the extent of pollution under certain conditions. From this, some deductions can be made as to the effect of pollution under similar conditions. However, it would be erroneous to apply these measures to problems elsewhere unless there is a considerable similarity in controlling conditions such as porosity of the soil, elevation and fluctuations in the ground water table and hydraulic gradient. The field worker should be guided by consideration of the basic fundamentals, adjusted by experience gained locally, while retaining the results of the experimentation cited as a general background.

Summary

1. The extent of travel of pollutants in ground water is limited in direction, distance and intensity.
2. These limits are controlled by the environmental conditions affecting bacterial metabolism and the nature of ground water flow both in the zone of aeration and the zone of saturation.
3. The viability of the organisms in an unnatural environment is important. The slope of the time-concentration curve is influenced by temperature, pH, moisture and food supply. The more unfavorable these conditions are, the greater will be the diminution in the number of living organisms.
4. The time of ground water flow between the source of pollution and the source of water supply is influ-

enced by precipitation, porosity of the soil and rise and fall of the water table.

5. The filtering capacity of the soil and the clogging of interstices between grains affect the travel of pollution.

6. Careful experimentation has provided a quantitative measurement of the travel of pollution under certain conditions.

Grateful acknowledgment is made to: Mr. George L. Hall, Chief Engineer, Maryland State Department of Health, for valuable assistance in preparing the paper; Mr. M. H. Coblentz, Senior Assistant Sanitary Engineer, Maryland State Department of Health, and Mr. John C. Geyer, Associate in Sanitary Engineering, The Johns Hopkins University, for reviewing the paper and suggesting certain revisions; and to Mr. F. C. Kuska, Junior Assistant Sanitary Engineer, Maryland State Department of Health, for preparation of the sketch.

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8. *Studies of Subsoil Pollution in Relation to Possible Contamination of the Ground Water from Human Excreta Deposited in Experimental Latrines*, Elfreda Larson Caldwell, Journal of Infectious Diseases, Vol. 62, May-June, 1938.

WATER AND SEWAGE PATENTS

(Issued Recently)

Reported by JULIAN F. SMITH
ASSOCIATE DIRECTOR
Hooker Scientific Library, Center College
FAYETTE, MO.

This page constitutes a recently added service to readers of WATER WORKS AND SEWERAGE, *many of which are interested in keeping informed as to what is new in the way of patents issued in the water, sewage and allied fields.*

It is proposed to print these patent abstracts in alternate issues, or more frequently if the number becoming available justifies. This service began with our March, 1941 issue.

Water

Water Softening Reagent. F. E. Hubbard and C. R. McCullough (to Monsanto Chemical Co.) U. S. 2,244,158, June 3. Aggregating sodium hexametaphosphate in granules of such structure that they dissolve more rapidly than does the original material, which is of dense glass-like structure.

Filter Bed. Harry M. Danner. U. S. 2,244,188, June 3. A filter bed composed of mineral particles is arranged with a series of wash water troughs nearly touching the surface of the bed, in such a way that wash water will flow through all parts of the filter at the same rate.

Pipe Laying Tool. Wm. C. Johnson. U. S. 2,244,202, June 3. A tool for laying underground pipe and for removing damaged pipe sections. It has a threaded collar at one end and means at the other end for supporting a new pipe section.

Meter Cleaner. L. C. Eldridge (to Baton Rouge Water Works Co.). U. S. 2,244,292, June 3. A device for supporting a meter by its inlet and outlet connections, and passing cleaning solution and water through the meter by means of a multiway valve system.

Feed Water Treater. W. H. Hinsch (to Dearborn Chemical Co.). U. S. 2,244,698, June 10. Apparatus for treating feed water is mounted on the tender of a locomotive, so that reagent entering the locomotive tank is proportioned to the flow of raw water into the tank.

Pipe Joint. Arthur T. McWane. U. S. 2,245,153-4, June 10. A joint for bell and spigot pipe has a packing groove on the bell section, and a tightly stretched rubber gasket (or gasket and clamping ring) on the spigot section to fit the groove.

Treating Tank. W. H. Green (to International Filter Co.). U. S. 2,245,583, June 17. A cylindrical tank with an agitator at the bottom, has an open end casing near the bottom with means for introducing into the casing a reagent and the liquid to be treated.

Water Softener. W. J. Hughes (to Infilco, Inc.). U. S. 2,245,587, June 17. Maintaining a pool of slurry in the bottom of water softening apparatus and percolating water upwardly through the slurry, withdrawing clear water from above after precipitation of the hardness components.

Clarifying Water. W. J. Hughes (to International Filter Co.). U. S. 2,245,588-9, June 17. A clarification tank is divided into mixing and circulating compartments, communicating near the top, providing a means for coagulating and removing the solids which cause turbidity.

Water Softener Valve. E. E. Eickmeyer and A. G. Horvath (to Dayton Pump & Mfg. Co.). U. S. 2,245,767, June 17. A water-softening sequence in which hard water is

passed through a mineral bed, fresh water is passed through in the opposite direction and regenerating brine is then passed through the bed, these operations being facilitated by a single control valve.

Pipe Cleaner. Wm. T. Tate. U. S. 2,246,421, June 17. A scraper bar for pipe cleaners, has curved cutting blades and a serrated rib which intersects the blades, the blades increasing in height from front to rear so that the last blade is as high as the serrated rib.

Anion Exchange Resin. E. Melof (to National Aluminate Corp.). U. S. 2,246,526-7, June 24. Condensing a monoacylated aromatic polyamine with formaldehyde or acetaldehyde to form an anion exchange resin; and making a similar resin by acid condensation of toluidine with formaldehyde.

Automatic Pumping Plant. Thaddeus S. Harris. U. S. 2,246,678, June 24. An automatic cistern and deep well pumping plant has an electrically operated suction force pump, a well water tank, a cistern and a cistern tank, with suitable control devices to enable the pump to supply either tank.

Water Inlet Valve. David Sherwood (to Sherwood Brass Works). U. S. 2,247,525, July 1. A valve for controlling flow of water into tanks has an outlet chamber which is vented to the atmosphere, and a pressure responsive valve controlling the vent.

Water Treatment. Verl E. McCoy. U. S. 2,247,762, July 1. Proportioning a water treating chemical by maintaining separate supplies of water and reagent solution in a predetermined ratio of surface areas and draining reagent into the outflowing water in a predetermined volumetric ratio irrespective of the variable rate of outflow.

Softening Water. Paul G. Bird. U. S. 2,248,055, July 8. Passing raw water first through an acid and then a base exchanger, and regenerating the spent exchangers with acid and then raw water for the acid exchanger, and with alkali, soft water, and finally the acid exchanger effluent for the base exchanger.

Purifying Water. Adolf M. R. Karlström. U. S. 2,248,177, July 8. Gasifying raw water in a conveyor on the way to a tank where the undissolved gas is removed, then passing it to a separating tank, where gas charged particles are floated and removed.

Sludge Separator. Ernest F. Fisher. U. S. 2,248,665, July 8. A sludge separating tank having a sump below a vertical weir wall which divides the tank into a sludge compartment and a clear liquid compartment.

Water Analyzer. Wilfred F. Langelier. U. S. 2,248,765, July 8. Apparatus for determining water hardness by measuring the opacity of a dispersion of air in aqueous soap solution.

Flow Valve. Jas. S. Thompson. U. S. 2,249,586, July 15. A flow valve for a reservoir contains a Venturi tube with a perforated throat flaring from end to end and merging into conical outlet having a discharge well at its end.

Safety Hydrant. Denis F. O'Brien. U. S. 2,249,848, July 22. A hydrant valve stem coupling, which will carry service stresses but will break under impact, to prevent damage to the hydrant, is grooved sufficiently to be frangible when struck.

Pump. F. H. Johnston and A. E. Du Bois (to Premier Engineering Co.). U. S. 2,250,419, July 22. A power driven shallow well water pump having an air chamber and a vacuum chamber operated in cycles.

Sewage and Wastes

Garbage and Sludge Disposal. P. B. Streander (to Municipal Sanitary Service Corp.). U. S. 2,246,224, June 17. A degreasing unit for treating garbage, or garbage and sewage solids, by floating the grease as a froth layer.

Waste Pulping Liquor. H. R. Murdock (to Champion Paper & Fibre Co.). U. S. 2,247,584, July 1. In recovering pulping chemical from waste sulphate liquor the sodium content of the original liquor is restored by adding a by-product spent caustic from oil refining and the solids of the waste liquor are incinerated.

Ozonizing Sewage. Geo. T. Brownell and W. J. Woodham. U. S. 2,249,739, July 22. Sewage with high colloid content is ozonized by releasing ozone within the liquid and by exposing its surface to ozonized air.

Geo. S. Rawlins, C. E., Joins J. N. Pease, Engrs.

J. N. Pease & Co., well known Engineers and Architects of Charlotte, N. C., announce that George S. Rawlins, consulting engineer of Charlotte, has become associated with the firm.

Mr. Rawlins, prior to entering the consulting field, had charge of design and construction of important additions to and complete revamping of the Charlotte Filter Plant and Pumping Station, and installation of new pumps and larger force mains, which resulted in sizeable reductions in pumping costs. Upon completion of this work he entered the consulting field.

Loran Gayton Elected President by Chicago Engineers

Loran D. Gayton, Chicago's Principal Ass't City Engineer, was elected Vice-President of the important Chicago Chapter of the American Public Works Association on July 1st. This honor followed another recently coming to Mr. Gayton when he was elected President of the Chicago Engineers' Club in April.

Known to his many friends as "Larry," Mr. Gayton entered the employ of the city of Chicago in 1914 and passed seven promotional civil service examinations which took him to the top in Chicago's Dep't of Public Works where he had charge of all water works design and construction. For filtration he has always been a consistent and tireless worker, and his efforts have resulted in what is to be the "world's largest" filter plant now under construction to serve Chicago's taste-suffering South Side.

CHLORINATION EQUIPMENT FOR EMERGENCY USE*

By HARRY A. FABER,
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THE CHLORINE INSTITUTE, INC.,
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THE purpose of this paper is to provide specific information regarding material and equipment which is available for or which may be adapted to emergency chlorination of water supplies.

Normal treatment and distribution of a safe water supply is subject to interruption by acts of nature or of man. It has been pointed out (1) that because a public water supply is essential both for domestic needs and for fire fighting, water department authorities have a definite responsibility to provide equipment which will insure the minimum interruption of water service.

During the past few years, experience has demonstrated not only the necessity of continual vigilance under normal conditions of operation but the necessity of being prepared to meet abnormal conditions of operation. Chlorination is recognized as a necessary factor of safety in the normal treatment of water supplies. It is equally essential that provision be made in time of emergency to insure the delivery of water disinfected by chlorination.

The experience of those who already have gained familiarity with this problem provides the best basis for development of any new program. Descriptions of those procedures demonstrated to be effective warrant careful study. Papers by Arnold[2] and by Devendorf[3] report a variety of experiences with emergency chlorination measures. These were adopted to treat public water supplies contaminated under conditions of normal operation. Papers by Gledhill and McCaulis[4] and by MacKenzie[5] describe the development of successful disinfection procedures for combating pollution resulting from fracture of water mains by high explosive bombs.

In order to perfect a clear plan of action, it is necessary to determine the requirements of each supply and each situation. Experience shows

H. A. Faber

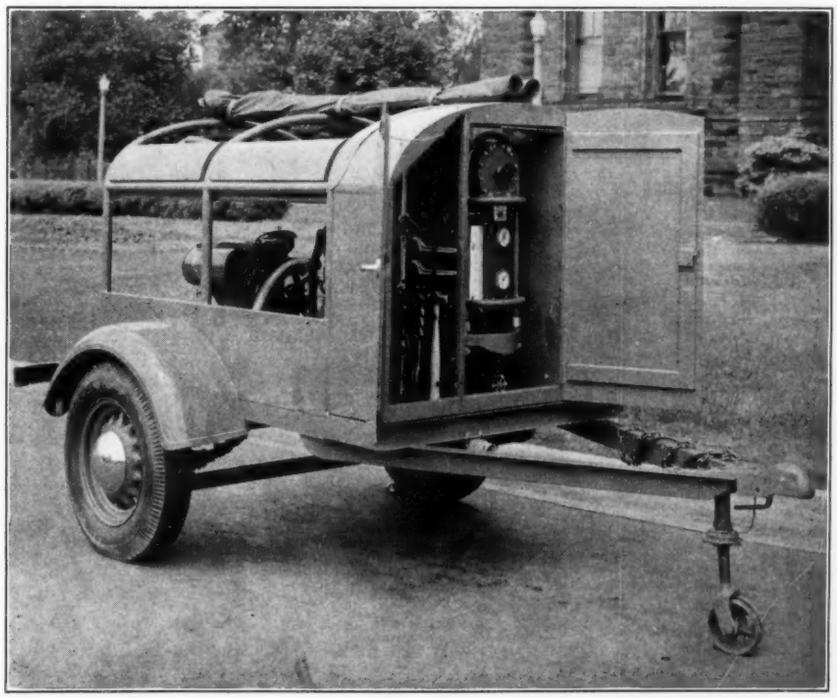
this can best be accomplished by providing three essentials: The man, the material, and the machine.

The Man

Prompt and effective emergency chlorination can be no better than the personnel which has been made responsible for the job. General rules of procedure cannot be laid down for all municipalities, or all supplies, or all emergencies. Rather, the plan developed must be based on the conditions which obtain in each locality.

Authority should be delegated to a competent member of every water supply organization to survey the local situation. His survey should include a study of each potential weakness in the normal operation of water chlorination. This is no time to place dependence upon inadequate or obsolete chlorinating equipment. This is no time to lack duplicate chlorinating units or spare parts necessary to uninterrupted operation. This is no time to lack the protection of secondary chlorination at points where recontamination is possible; at storage reservoirs, floating reservoirs, and distribution reservoirs.

Under abnormal conditions a water department may find itself called upon to supply much more than the

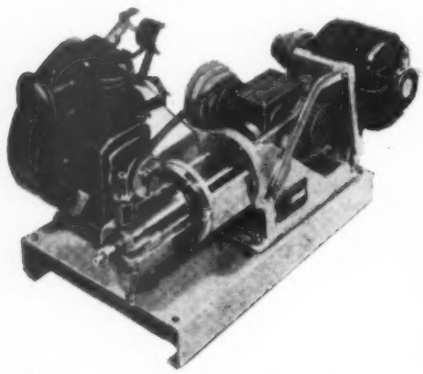


Wallace & Tiernan's Newest Mobile Emergency and Utility Chlorinating Unit
Carries two cylinders of chlorine and gasoline engine driven injector water pump, all necessary tools and especially designed chlorinator of high flexibility.

*This paper, presented at the Toronto Convention of A.W.W.A., is here reproduced by permission of the Association.

normal quantity of water, either because of wastage from broken mains or in order that fire fighting can be carried on effectively. Chlorinating equipment must be ample in capacity to disinfect increased volumes of water required by these causes.

Under emergency conditions, special portable or mobile units may be required either to disinfect contaminated sections of a distribution system or to treat a separate emergency supply. The survey should consider each of these contingencies because, while abnormal, they are certainly potential occurrences.



Proportioneers' Hypochlorite Feeder

Designed for general utility and emergency use this model of "Chlor-O-Feeder" is equipped for electric drive (1/6the H.P. motor) and engine drive (½ H.P.).

When this survey is completed it will reveal the strength and weakness of the local situation: where chlorination is necessary, where it is provided, and where additional or emergency chlorination may be required. This survey, however, represents only the recognition of the situation.

The second step, therefore, is to provide the indicated total protection to the best possible degree. In the case of a small water system, only minor provisions may be required. while in the case of an extensive system many weaknesses may require correction. There will probably be no better time than the present to secure funds for providing new equipment.

Finally, a detailed plan of procedure should be worked out and put in written form. Each chlorinating unit and each point of chlorine application is a point of potential disinfection failure; therefore, the detailed plan should indicate as simply as possible exactly what procedure is to be followed in the event of such failure. If a duplicate unit is to be substituted, if an emergency unit is to be provided, if the chlorine dose is to be increased elsewhere, that instruction should be clearly stated.

The individual who has studied the entire situation and who has drawn up the detailed plan of procedure, would then be the logical man to whom full authority should be delegated. Only when complete responsibility is given to one individual will prompt and decisive action be forthcoming. This is necessary also because the chlorination authority must cooperate with those responsible for other phases of emergency procedure. The program of emergency chlorination must be integrated with the entire program of plant operation, distribution system repair, and emergency sources of supply.

Such a precautionary program is applicable, irrespective of the size or number of employees of the water system. Only when one individual is given responsibility and adequate precautionary measures have been provided can criticism be forestalled, excessive emergency expenses be prevented, and the well-meaning but often dangerous efforts of incompetent individuals or organizations be discouraged.

The Material

Liquid Chlorine

The assured availability of liquid chlorine for disinfection of water supplies has been reviewed (6). In the event of emergency, it is not probable that large additional amounts of chlorine will be required; instead, different points of application would be utilized.

However, the proposed plan of emergency procedure should include a survey of listing of emergency sources of chlorine supply. Nearby sewage treatment plants, swimming pools, laundries, or industrial plants should be contacted, and the potential emergency supply of liquid chlorine available from such sources should be determined.

Hypochlorites

Many small water treatment plants regularly use calcium hypochlorite for disinfection. This chlorine compound provides an excellent source of emergency chlorine for even the largest plants. The modern calcium hypochlorites contain 70% available chlorine, and are generally supplied in drums containing 100 pounds and in cans containing 5 pounds of the dry material.

Two such hypochlorites are available in the United States: "HTH", manufactured by the Matheison Alkali Works, and "Perchloron", manufactured by the Pennsylvania Salt Mfg. Co. In Canada there is one such hypochlorite: "Maxoclor", manufactured by Candian Industries, Ltd. Each producer has available a booklet which provides useful information on the preparation and feeding of hypochlorite solutions.

This material may also be available through local distributors who supply laundries, industrial users, swimming pools, and other consumers. Each of these sources should be surveyed as a potential source of supply when facilities are provided to feed hypochlorites.

The Wilson "Pulsafeeder"

This pumping type feeder employs the principle of hydraulic "squeezing" of the elastic pulsating tube passing through the compression chamber seen at upper right. The piston stroke determines the degree of tube squeeze and feed rate, up to 75 gals. per hour for this particular model.

These hypochlorites are stable over a long period of time, if stored in a cool dry location. When dissolved in water the resulting hypochlorite solutions are corrosive to common materials, hence suitable equipment must be available to feed these solutions.

Other Chlorine Compounds

So-called "bleaching powder" or "chloride of lime" is available from local distributors in many localities. This material generally contains about 35% of available chlorine when fresh, but is not stable over a long period of time. Local sources should be investigated, however, if emergency equipment for feeding hypochlorite solutions is provided. Limited amounts of this material may also be found in drug, grocery, hardware, or poultry supply stores in one pound cans.

Sodium hypochlorite solution, usually containing about 15% of avail-

able chlorine, is obtainable through local jobbers in some localities. This solution may be purchased in 5 gallon carboys. Frequently small producers of household bleaching solution used this material, or make it from caustic soda and liquid chlorine, and market it under a wide variety of trade names in grocery stores. As sold, the household solution is usually very dilute, ranging from 3% to 5% available chlorine. It might be used in an emergency to provide very small amounts of chlorine.

The Machine

Chlorinators

Standard chlorinating apparatus is not an unusually heavy piece of equipment. The units regularly employed in water purification may be readily transported in emergency to various points of need. Chlorinator manufacturers are best able to designate the type of equipment most suitable for particular uses. There are two manufacturers of chlorinators: Wallace and Tiernan Co., Newark, N. J., and Everson Manufacturing Co., Chicago, Ill. They offer standard chlorinators suitable for various types of installations and for a wide range of dosage requirments.

Wallace and Tiernan Co. is experienced in the design and construction of mobile chlorinating units, using standard vacuum chlorinators, and has assisted in the design of other such units which were assembled and mounted by the customers. This company offers a stock model portable chlorinator, suitable for either direct or solution feed, which is especially applicable for main sterilization. The outfit is mounted in two compact cabinets, and is adaptable to a variety of uses. In addition, a new mobile trailer unit has been designed, completely equipped with a chlorinator, two cylinders of chlorine, and a self-powered pump. One of the newest of these units was on exhibition at the Toronto Convention of A.W.W.A. and is here pictured. It is a unit of considerable flexibility and its range of capacity is large.

Pumps for Feeding Hypochlorite Solution

Small pumps, which operate on a variety of principles, are available to feed hypochlorite solutions for disinfection. They are constructed of resistant material and have proven thoroughly satisfactory in service. Again in this case, the manufacturers will be most competent in designating the type of equipment best suited to each purpose. The units are suitable for continuous, emergency, or special chlorinating purposes and may be either manually controlled, operate automatically at a fixed dose, or provide a dose directly proportional to water flow.

The two types of this equipment best known in the water treatment field are those manufactured by Proportioneers, Inc., and by Wallace and Tiernan Co.

Proportioneers, Inc., Providence, R. I., offers a wide variety of such pumps under the name of "Chlor-O-Feeders". These range in capacity from 85 to 240 gallons per day maximum delivery. They operate by electric power, belt drive, waterpower, compressed air, or by power from a gasoline engine. In addition, duplex, triplex, and combinations up to 5 units can be provided with a capacity of 180 gallons per day for each pump. In addition, this firm also manufacturers the "Pur-O-Pumper" unit, consisting of pump, filter, and hypochlorite feeder. It is powered with a gasoline engine, and therefore is a self-contained unit for producing filtered and chlorinated water.

Wallace and Tiernan Co., Inc., Newark, N. J., offers several models of a hypochlorite pump feeding a maximum of 60 gallons per day. These "Hypochlorinators" operate by electric power, belt drive, water power, or by power from a gasoline engine. Duplex pumping units are also provided in this equipment. Self-contained units, consisting of pump and hypochlorinator or of pump, filter, and hypochlorinator, are also available.

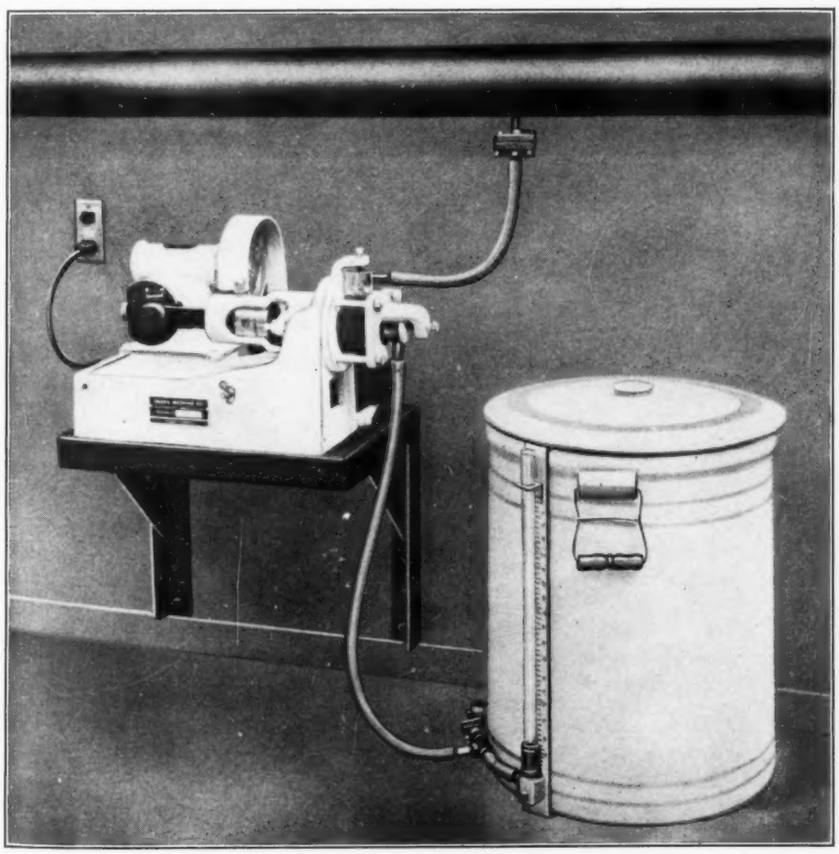
Other manufacturers offering a more limited variety of hypochlorite pumping units are:

Omega Machine Co., Kansas City, Mo. One model, electric or water power, 400 g.p.d. maximum capacity.

Everson Manufacturing Co., Chicago, Ill. One model, electric power, 24 g.p.d. maximum capacity.

Milton Roy Pumps, Philadelphia, Pa. Simplex model, electric power, 432 g.p.d. maximum capacity: duplex model 864 g.p.d. maximum capacity.

Wilson Chemical Feeders, Inc., Buffalo, N. Y. Five models of "Pulsafeeders" operated on electric or water power, standard capacity 96 g.p.d., and others.



The Omega Hypochlorite Feeder

Pictured installed on standard wall bracket. The 15 gallon stoneware solution crock is equipped with a liquid metering gauge.

The Hills-McCanna Co. of Chicago, also produce pump type chemical feeders, especially suitable for injecting solutions against high pressures.

Hypochlorite Feeders Other Than Pumps

Omega Machine Co., Kansas City, Mo. offers a "Precision" feeder to deliver hypochlorite solution against zero back pressure or to a pump suction. This device consists of a solution tank from which the discharge rate is controlled by electric motor, spring operated clock drive, water motor, or by any reciprocating or rotating shaft. Maximum capacity is given as 192 g.p.d.

Phipps and Bird, Inc., Richmond, Va. offers a hypochlorite solution feeder, operating by either gravity or electric power, to deliver against back pressures of zero or up to 60 pounds. Maximum capacity is given as 45 g.p.d.

C. W. Sirch, Los Angeles, Calif. offers a "Paradox" feeder for hypochlorite solution, which operates by pressure differential between two points in the water main. Discharge rate is over a large range.

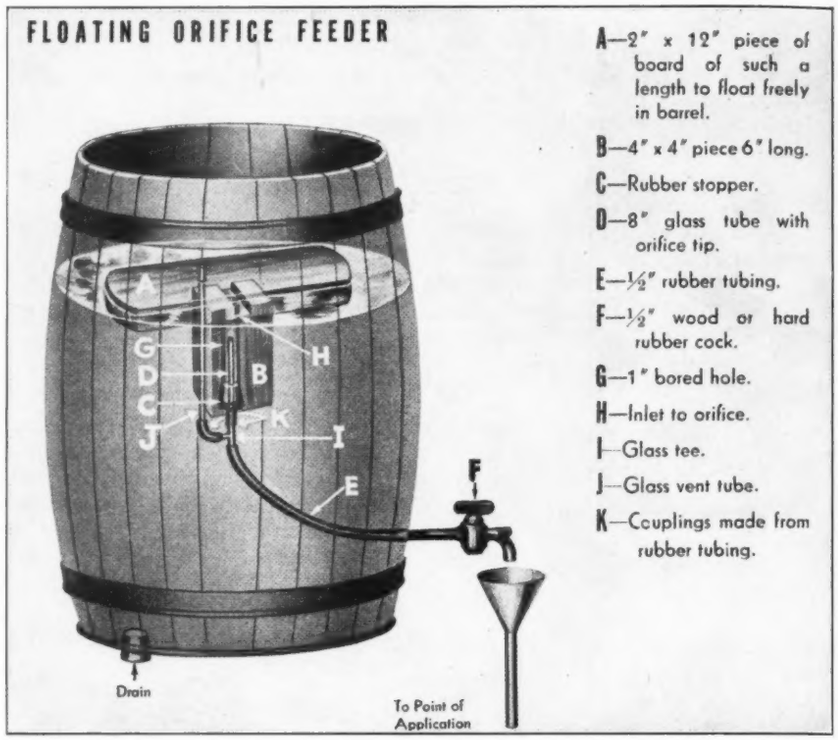
Home Made Hypochlorite Feeders

For temporary application of hypochlorite solution under emergency conditions, a variety of other feeding devices can be pressed into service. They should, however, be considered for temporary use only.

In emergency, any dry feed machine may be used to feed dry hypochlorites into a solution box, and the solution may be discharged by gravity or pumped to the required point of application. Only the 70 per cent calcium hypochlorite can be fed in such manner. Even this material is slightly hygroscopic and corrosive upon exposure to moist atmospheres; therefore, dry feed application must be limited to short periods of use only when no other equipment can be provided.

Several types of gravity or pump suction feeders can be made to serve during an emergency when no standard solution feed device can be provided, though their accuracy and dependability can never compare with equipment designed for this purpose. Hypochlorite solutions are corrosive to common metals, and parts used must be of suitably resistant materials such as glass, wood, rubber hose, hard rubber fittings, etc.

Hypochlorite solutions can be applied against pressure by using an injector. The pressure differential between the injector feed and discharge should preferably be 5 to 1 and must be at least 3 to 1 in order to obtain satisfactory operation.



(Picture by courtesy Penna. Salt. Mfg. Co.)

Floating Orifice Solution Feeder

This type of emergency-gravity type feeder has the advantage of requiring no constant head box. The feed is adjusted by the simple expedient of raising or lowering the submerged glass orifice tube which feeds out the contents of the barrel under constant head. The barrel can be refilled at any time.

Residual Chlorine Testing Equipment

Proper control of chlorine dosage will usually be dependent upon the maintenance of a desired chlorine residual. Testing outfits are available both for the residual range covered in ordinary disinfection and for that which may be necessary in emergency chlorination.

For chlorine residuals of 0.1 p.p.m. to 1.0 p.p.m., outfits are offered by: La Motte Chemical Products Co., Baltimore, Md.; Proportioneers, Inc., Providence, R. I.; Rascher & Betzold, Inc., Chicago, Ill., and W. A. Taylor & Co., Inc., Baltimore, Md.

For chlorine residuals of 0.1 p.p.m. to 2.0 p.p.m., outfits are offered by: Hellige, Inc., Long Island City, N. Y., and by Wallace & Tiernan, Inc., Newark, N. J.

For chlorine residuals of 0.2 p.p.m. to 8.0 p.p.m., an outfit is offered by W. A. Taylor & Co., Inc., Baltimore, Md.

For higher chlorine residuals, outfits ordinarily used in testing bleaching or sterilizing solutions are offered by: Diversey Corp., Chicago, Ill. (100 p.p.m. maximum); Hellige, Inc., Long Island City, N. Y. (250 p.p.m. maximum); La Motte Chemical Products Co., Baltimore, Md. (100 p.p.m. maximum); The Mathieson Alkali Works, Inc., New York, N. Y. (220 p.p.m. maximum); Rascher & Betzold, Inc., Chicago, Ill. (220 p.p.m. maximum); W. A. Taylor & Co., Inc., Baltimore, Md. (250 p.p.m. maximum).

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BAYPORT, MINN. (4)	Williams Eng. Co.
BEL NOR, MO. (3)	Russell & Axon
BELLEVILLE, ILL. (2)	James G. Cooney
BELVIDERE, ILL. (4)	Marr, Green & Opper
BERTRAND, NEB. (3)	H. A. Davis
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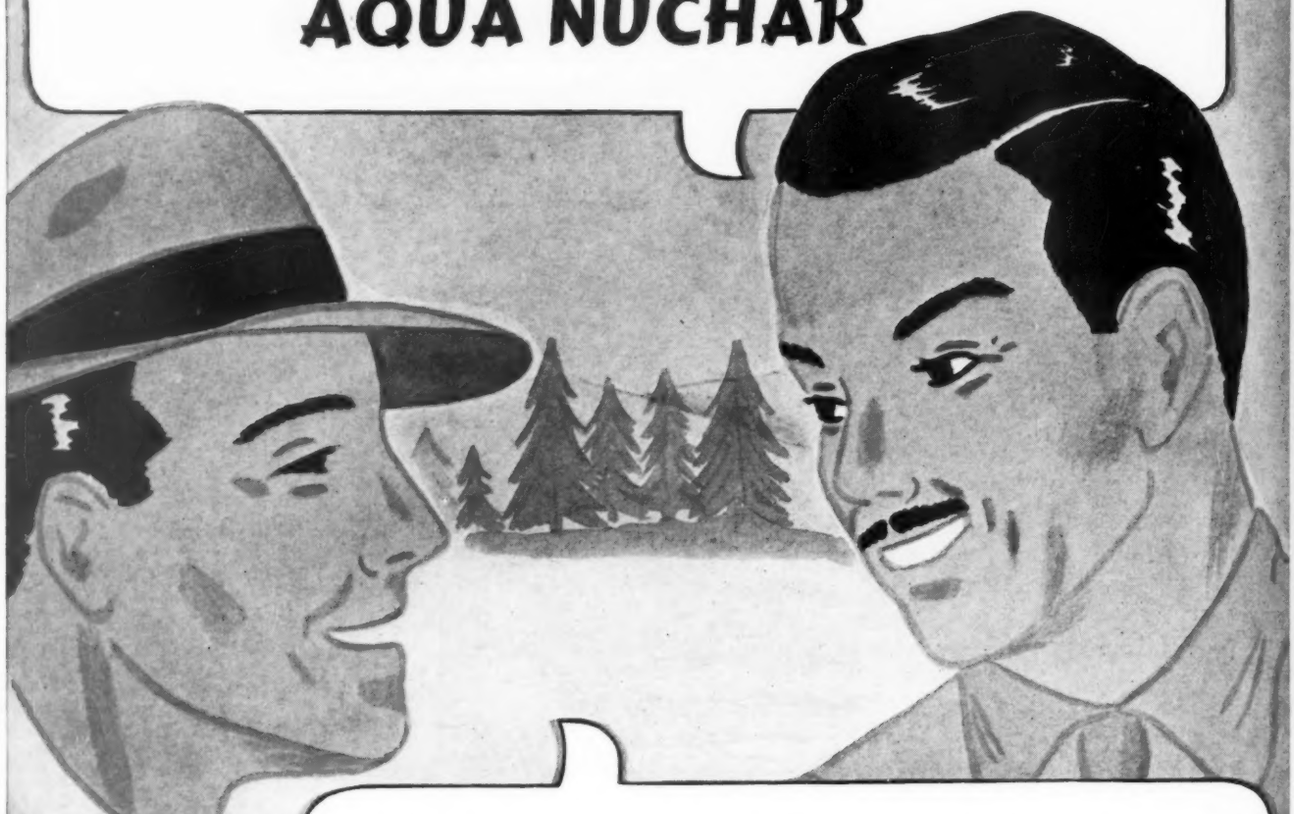

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WATER METER MAINTENANCE PRACTICE*

As Conducted in Thirty-Six Cities in the United States and Sixteen Canadian Cities

By A. P. KURANZ
Superintendent, Water Department
WAUKESHA, WISCONSIN

AT THE request of officials of the American Water Works Association a survey has been made on "Meter Maintenance Practice" in cities over 30,000 population in Canada and in cities in the United States between 100,000 and 200,000 population. A questionnaire, developed with the assistance of several superintendents, was sent to 21 Canadian cities and 47 United States cities.

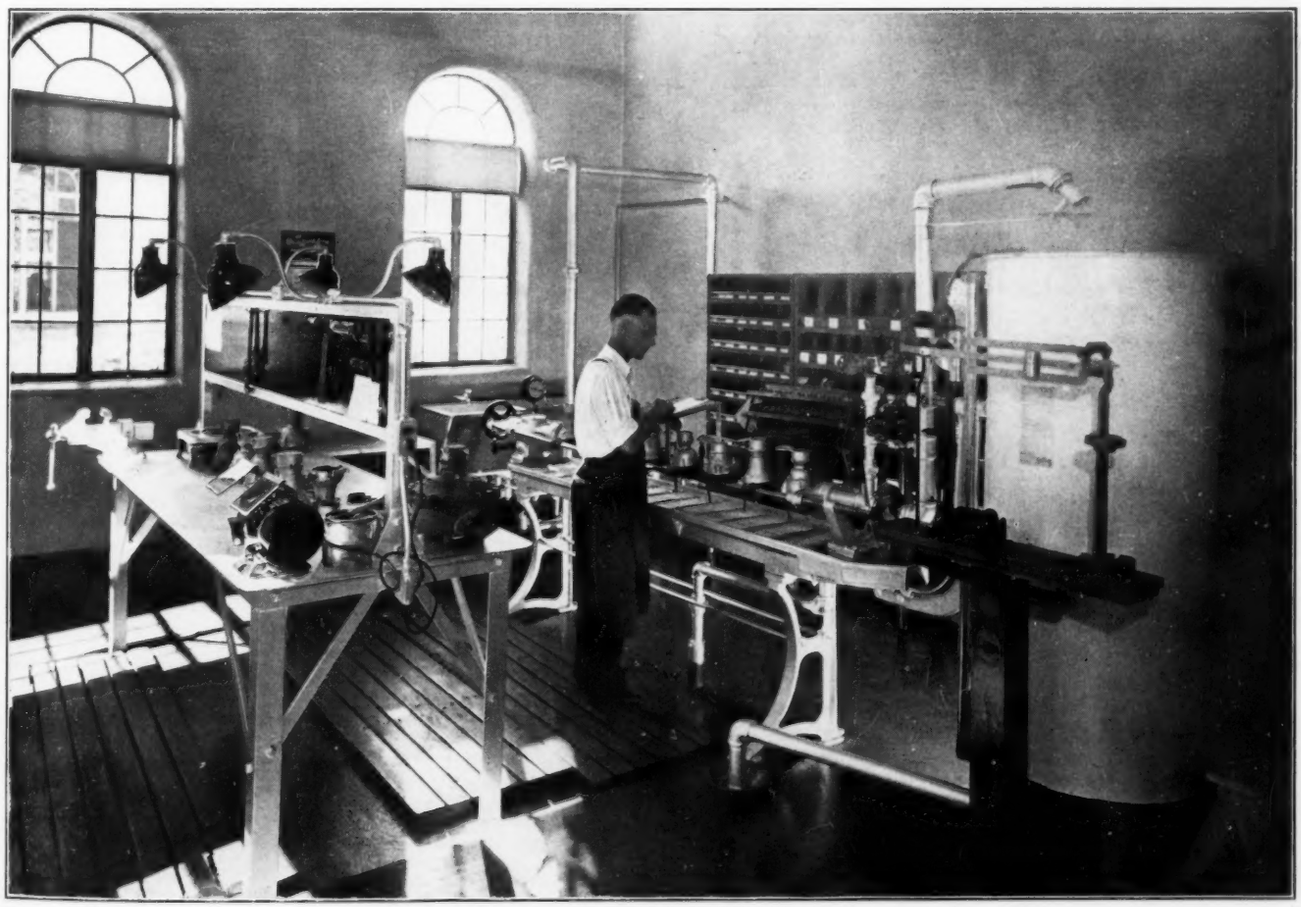
Before proceeding further, let me express my appreciation and thanks to every water department and its officials who so enthusiastically responded to the questionnaire. Canadian cities returned 16 or 76.2% and American cities 36, representing a 76.6% return. The replies came in within a short time after the questionnaires were sent, indicating great interest concerning this subject. Many letters were attached to the questionnaires which gave additional information and encouragement in the work undertaken. It was a distinct privilege and pleasure to be permitted to make this survey and I trust that the answers and the analyses made will prove of some assistance to you.

The Author

What the Returns Revealed

Upon studying the returns, it was observed that the ¾ in. meter was usually included with the ⅝ in., so a separate analysis of these two sizes appears to be uncalled for. The 1 in. size was treated very similarly to the ⅝ in. The only great difference being in the registration permitted before meters were removed for test-

*A report made by the author to the American Water Works Association in Toronto June 26, 1941. It is here reproduced by permission of the Association.



A Portion of The Author's Meter Shop at Waukesha, Wis.

[*Recipient of the Geo. W. Fuller Award, Mr. Kuranz was cited—"For his outstanding work in developing meter testing methods and meter maintenance procedure."—Ed.*]

ing and renovation. In all other respects the 1 in. meter was grouped with the ⅝ in. and ¾ in., even to the test requirements and cost of repairs. There was not sufficient individual data to warrant repeating the analysis, so this survey deals entirely with the ⅝ in. disc type water meter.

Question No. 1

Do you test all new meters before you put them into service? If you test new meters, what is the lowest flow in G.P.M. at which they are tested, and what accuracy do you demand?

37 cities test *all* meters
7 cities test from 1 to 25%
8 cities do not test

Cities	Rate of Test	% Demanded
1.....	.04 g.p.m.	75
4.....	.125 to .2 g.p.m.	90- 98
5..... ..	.250 g.p.m.	90- 95
5.....	.3-.5 g.p.m.	95-102
3.....	.8-.873 g.p.m.	96-102
4.....	1.0-1.5 g.p.m.	98-102
3.....	2.0-8.0 g.p.m.	98-102
1.....	20.0 g.p.m.	98-102
1.....	1/32″ orifice	100
6.....	1/16″ orifice	98-102
11.....	1/4″ orifice	98-102

It will be noted that the majority of the cities test their meters when they are purchased or before they are placed in service. While most cities test their meters, it will also be observed that comparatively few test on the minimum requirements, namely, ¼ g.p.m. Only 11 cities of the 52 test their meters on ¼ g.p.m. or less, including one city testing on 1/32 in. orifice. It appears that most water departments are concerned with proper registration in the class ranging from 0.3 g.p.m. to 1.5 g.p.m. However, surveys available, revealing that approximately 12 to 15% of the water passing through a house meter passes at a rate of ¼ g.p.m. or less, would indicate that all meters should be tested at the lower flows.

The survey further indicates that there are still a considerable number who use the orifice method of testing, even though the method has become obsolete and is no longer recommended for accurate test.

Question No. 2

Do you remove meters after a certain amount of water has passed through them or do you set a period of time between removals?

Cities	Period Between Removals
11 ...	4.5 to 5 years
5....	6 to 7 years
4....	10 to 20 years
15....	Consumption — stopped — slowing down—complaint
11....	Consumption and time (375,000 to 1,500,000 gallons)
6....	No answer

The survey indicates that there is a definite interest being shown in the problem of having meters returned to the shop for periodic inspection. The period varies greatly and, no doubt, is caused by the action of the individual waters upon the meters. Only a few are permitting the meters to stop or slow down and only one uses the complaint method for removal cause. Eleven of the 52 cities reporting reveal that they use time element and consumption, which apparently is the most efficient way of handling this problem.

Question No. 3

Do you remove meters in a certain section of your city or do you follow the selective manner?

Cities	Method
8....	By section of city
33....	Selective
2....	Both
9....	No answer

Replies to question No. 2 have brought before us the fact that greater attention is being paid to the meter, and the fact that 33 of the 52 cities use a selective means of removal for test further indicates that the meter is not installed and then forgotten.

Question No. 4

How much time per meter is required to bring a meter into the shop?

Cities	Time Required
8....	10 to 20 minutes
6....	22 to 28 minutes
10....	30 minutes
8....	40 to 50 minutes
9....	60 minutes
1....	90 minutes
10....	No answer

The survey shows that there is some variation, but no doubt a more detailed survey of what is involved in the removal of a meter might give us greater knowledge. When 41 of the 52 cities report from 10 minutes to 1 hour, it seems that the time required all depends upon how much additional work is necessary to restore service to the customer after the meter had been removed.

Question No. 5

Do you test meters as they are brought into the shop for repairs? If your answer is "yes," what is the lowest flow at which they are tested?

Cities	Answer
37....	Yes
4....	On complaint or request
11 ...	No
Cities	Rate of Flow
3....	.14-.2 g.p.m.
8....	.25 g.p.m.
12....	.3-1.0 g.p.m.
2....	1.5-2.5 g p.m.
3....	5.0-8.0 g.p.m.
1....	Full flow
3....	1/32″ orifice
6....	1/16″ orifice
2....	1/4″ orifice
12....	No report

The replies to this question indicate clearly that the manager or superintendent is keenly interested in what his meter has done or is doing under actual working conditions. The second part of the question further indicates this view because quite a number test the meter on a small flow. Again attention is called to the use of the orifice method of testing which has become obsolete.

Question No. 6

Do you take the meter apart completely? If you take only part of the meter apart, what part?

Cities	Method
50....	Complete disassembly
2....	In part only
3 (of 50)	take a part only on low test

From the answers to this question, it is very evident that the utility is concerned about keeping the meter in good repair, otherwise meters would not be completely disassembled.

Question No. 7

What method of cleaning disc chambers do you use?

Cities	Method
31....	Use brush, scraper, emery cloth, sandpaper, powder (either alone or in combination)
10....	Use brush, scraper, emery cloth and acid in combination
8....	Use acid only
1....	Uses powder and hot water
1....	Uses water only
1....	Uses all methods

This further bears out the fact that the water department is interested in keeping the "precision instrument" as near perfect as possible. Different waters, of course, will affect the meter materially, some responding to a certain kind of treatment while others are immune to it, but a survey such as this, which covers the United States and Canada, clearly indicates that mechanical means of removing foreign deposit or corrosion is still favored by most cities. Fine emery cloth and sandpaper and brush seem to be the chief implements used in removing foreign material. The small number using acid *only* indicates that departments have discovered that unless one is adept with the use of this material, more harm than good is done.

Question No. 8

Do you repair gear trains by putting in individual gears or a complete new train?

Cities	Method
30....	Individual
8....	Complete
14 ...	Both

Since practically all meter companies now make the all oil enclosed gear trains, the question has arisen concerning the maintenance of the gear train itself. It appears that most departments still believe that proper repairs can be made by replacing just the worn gears with new ones, instead of replacement of the

complete train. However, the mere fact that 8 use nothing but a complete train in repairing the gear train and 14 use both methods, indicates that the time element involved in substituting individual gears for the worn ones is an important factor.

Question No. 9

Do you test meters after they are repaired? If your answer is "yes," what is the lowest flow in G.P.M. at which they are tested and what accuracy do you demand?

To the first question, all 52 cities answered "yes." As to the test flows employed the following:

Cities	Lowest Flow Rate
2....	.04-.16 g.p.m.
10....	.25 g.p.m.
5....	.3-.5 g.p.m.
9....	.75-1.0 g.p.m.
5....	1.2-3.0 g.p.m.
3....	5.0-8.0 g.p.m.
1....	20.0 g.p.m.
3....	1/32″ orifice
8....	1/16″ orifice
1....	1/8″ orifice
4....	1/¼″ orifice

This is one question which was answered in the affirmative by all 52 cities in this survey. However, the rates of flow spread over quite a range, but upon analysis it seems little different than the test requirements on new meters. The question might be asked at this time whether or not flows on repaired meters should be as exacting as those on new. If we analyze the flows on the new meters and compare them with those for repaired meters, one would be inclined to say that most departments feel that the repaired meters should be as near equal to a new meter as possible. Your attention is again called to the fact that since considerable water is used from ¼ g.p.m. to zero in the average home, that greater attention be paid to the smaller flows.

Question No. 10

How much time per meter does it require to do the work covered in Questions 5, 6, 7, 8, 9? (Bringing meter into shop and testing, taking meter apart, cleaning chambers, repairing gear trains, testing after repairs.)

Cities	Time
9....	30 minutes to 55 minutes
10....	60 minutes
13....	70 minutes to 90 minutes
4....	120 minutes
6....	150 minutes to 210 minutes
10....	No report

Here again we find quite a variation. It can no doubt be explained that different operations are included and considerable time variation would be found in cleaning up the chambers as well as repairing the gear train. On the other hand, a majority of the cities seem to spend, roughly, 60 minutes per meter.

Question No. 11

What is the cost of repair parts ONLY based on a meter year basis? (Example: Cost of repair parts, $2.80. Meter removed every 7 years would mean that 40c per meter per year is the actual cost of repair parts only.)

Cities	Cost
1....	$ .008
10....	$ .06-$ .15
5....	$ .20-$ .29
7....	$ .30
4....	$ .345-$ .37
6....	$ .427-$ .48
3....	$ .50-$ .66
1....	$1.22
1....	$ .38 parts and labor
14....	No costs reported

Since all types and makes of meters are included in this survey, there may be a reason for the widespread difference, but it is believed the most important cause for this difference is the action of the water on the meter, which, in turn, necessitates a difference in time period between removals for test and repairs. Several factors enter into this problem, so when analyzed from every angle, the discrepancy may not be as great as it seems.

Question No. 12

At what cost of repair in relation to the cost of a new meter do you feel it uneconomical to repair meters?

Cities	Cost of Repair (Per cent)
3....	30 to 40
20....	50
4....	55 to 66⅔
7....	75 to 90
7....	Do not scrap
11....	No answer

Here there seems to be quite a general accord on what the answer should be. Nearly one-half of the cities reporting indicate exactly 50%. Most of them say between 30% and 66⅔%. No doubt the time element required to make repairs is balanced against the cost of the repairs and the improved registration resulting.

Question No. 13

When meter is repaired, do you set the register back to "zero" or keep a continuous record of the total registration?

Cities	Method
20....	Continuous
28....	Set back to zero
3....	Both

The answers to this question seem to have little bearing on the efficiencies of the meter, but it does indicate that careful records are kept by most departments as to the performance of the individual unit.

Question No. 14

What percentage of the water pumped is accounted for through meters?

The answers to this question varied so greatly that only by referring to notes and letters attached could comparison be made. Since cities are not all 100% metered, no fair figures can be obtained. Many apparently have no master meters, because some have gravity systems and therefore are little concerned as to the supply. However, those cities, which are 100% metered and which have adopted a good meter maintenance practice plan, account for a large percentage of the water pumped. No figures will be given, because a survey would have to be made of cities having all services 100% metered.

Conclusions

In summarizing the entire matter, at least one statement can be made without fear of being contradicted. That is where a city was found to have all its services metered and a carefully planned system of testing, repairing and cost recording, that city also enjoyed the distinction of accounting for a high percentage of the water pumped. One case is outstanding. The ten year average of accounted for water through meters is 88.2%, and the analysis made of this questionnaire clearly indicates that this city is very exacting as to testing, repairs and cost account of its meters. So often the water utilities install a meter and then proceed to forget that it really is a "precision instrument." If carefully watched and properly repaired and tested, it will more than repay you for the time and effort spent. It will be the instrument that will tend to keep your finances in proper balance. Too much stress cannot be placed upon the value of a proper meter maintenance program in your city, which program should include the following:

1. Test all meters when purchased.
2. Remove them after a certain time period or time and consumption combined.
3. Test them when brought into the shop for repair. Keep a record of these tests.
4. Repair carefully, especially chamber and gear train. Keep a record of repair costs, including labor.
5. Test after the repairs. Require a high percentage of registration on ¼ g.p.m. flow.

If you will do that, you will notice a distinct increase in your revenues. *Ask those who have followed this plan.*

The Editor's Comments

Securing Defense Rating a "Must" for Water and Sewage Plants

AWWA'S Special Committee on Defense, appointed by President Howson during the Toronto Convention, lost little time getting into harness and action. It is doing a real and extremely timely service in the interest not alone of AWWA members, but for water works and sewerage managers throughout the country.

Even before recommending to the Board of Directors that such a committee be established, Secretary Jordan had already been finding the right doors down in Washington. Since the convention, either alone or reinforced by members of the new committee, the Secretary has been making numerous key contacts in the Offices of Production Management and Civilian Supply. These first hand across-the-table interviews have accomplished much in the nature of having the water supply industry represented at court by representatives of a national organization in the industry, and have resulted in exchanges of information and understandings which is to go far toward making for a better and smoother working of relations between Federal authorities in control of priorities and allocation of materials, and water supply authorities; also, between both and the producers and suppliers of such materials.

In connection with this added duty on A.W.W.A.'s headquarters office, representing a worthy use of some of the ———— Association surplus funds, due to the highly satisfactory membership increase, the staff has been temporarily expanded to take care of the expanded correspondence between the A.W.W.A. office, members, manufacturers and Washington. In addition A.W.W.A. has been asked, and is now making a comprehensive survey of the field to give Washington a fair and dependable picture of materials requirements for the water supply industry during the next 12 months at least. Here is ample evidence of the value of a strong A.W.W.A. A few years back requisite funds for the purpose would not have been available. In our several writings as to the need for a larger membership in A.W.W.A. we referred to the fact that only with funds to do the job could A.W.W.A. produce what had been planned for the benefit of the profession. Here we have a splendid example of what was meant. The dollars that have accumulated as the difference between membership dues, since the expansion, and operating expense was ready for spending on such an extra activity in the interests of the water works fraternity. It is true that non-member managers (or cities) will benefit along with paying members. That is why we have so often said that *every* water utility in the country should contribute something toward the support of that Association which is automatically serving every municipally or privately operated water works, while some pay their way and the balance benefit without any return. So much for what A.W.W.A. found itself with necessary funds, and a well organized headquarters staff, to undertake in behalf of the public water supply industry. Now for some of the developments and high-lights that may be passed on to the water works fraternity.

As stated on another page of this issue chlorine was placed on the priority list by the O.P.M. only a few days after the close of the Toronto Convention, where the A.W.W.A. Board received assurances from the Director of Priorities that ample chlorine for water supply and sewage treatment would be assured. Within a few days after issue of the priority order on chlorine an order rating the highest civilian uses to be served, along with chlorine for direct defense, was issued to all chlorine producers. It will be noted that heading the short list of civilian uses to be accorded preference in filling orders is water purification and sewage treatment. This order of listing was no happenstance. Through direct efforts of the writer in Washington interviews, and those of Secretary Jordan through the U. S. Public Health Service, and those of the chlorine manufacturers, O.P.M. officials had become aware of the great necessity for an assured supply of chlorine in the production of safe water, which also involves adequate treatment of sewage in many instances.

A.W.W.A.'s Defense Committee and Mr. Jordan have learned in Washington that the situation in materials required in water works construction and maintenance is likely to become tighter as time goes on, since so many of these materials are the same that are under highest demands in the national defense program. In view of this probability, and although the Office of Civilian Supply has listed water supply and sewer service amongst essential public utilities to receive materials for maintenance and repair—ahead of other civilian uses, it is now known that *every water and sewage plant must apply for a rating*, under the terms of the order, before manufacturers are authorized to supply essential repair and maintenance materials as needed. In view of this disclosure it is highly important that every water works and sewerage manager get in touch promptly with the District O.P.M. office in his territory. The form to be filled out in application for a rating was reproduced in our April 1941 issue on page 156, as part of an article—"How to Secure Priority in Water Works Materials." If any reader failed to see this article a reprint will be sent upon request. The form in question (P.D.-1) has also been reproduced in the August issue of the A.W.W.A. Journal—see the 8 page insert printed on green stock.

In order to facilitate the procuring of detailed information, and filing of applications for ratings, O.P.M. has established 16 Field Offices. These are located in

the Federal Reserve Bank Buildings in the following cities:

Boston	Pittsburgh	St. Louis
New York	Cleveland	Kansas City
Atlanta	Detroit	Dallas
Philadelphia	Chicago	San Francisco

(Minneapolis and Richmond, also Federal Reserve Bank cities, as yet have no O.P.M. Field Office.)

In the following cities the O.P.M. Field Offices are located as indicated:

Cincinnati—Union Trust Bldg.
Denver—U. S. National Bank.
Los Angeles—Chamber of Commerce.
Seattle—Stuart Bldg.

It appears to be highly important that every water works and sewerage manager request Form P.D.-1 from his nearest O.P.M. Field Office and file promptly. It seems preferable to secure the form, fill it in, and file it in person to insure that all particulars are clearly dealt with and, thus, ratings will not be delayed.

In a memorandum from A.W.W.A. headquarters Mr. Jordan, as the result of an interview with O.P.M. officials, lays stress on the fact that water works authorities may not be able to procure equipment and materials to exactly meet A.W.W.A. specifications and must be content to accept materials which may be substituted for other materials that have been preferred, but in which scarcity of consequence exists temporarily. Furthermore, materials such as treatment chemicals may have to be accepted in a different size or style of container or package than the user has been accustomed to specifying. In other words, even though the water works and sewerage systems are admitted to be of ranking importance, we can not expect to be overly demanding in times when all hands should be giving and taking to make the sum total of future national safety add up correctly, and assuredly, in the quickest possible time.

The same memorandum points out that full use of existing equipment must be shown before new equipment desired will receive a rating which will insure early procurement. Materials for repairs and maintenance will be obtainable whereas those for extensions and replacements may be delayed until the degree of essentiality can be proven. Replacements because of obsolescence alone will not rate, and insistence on copper tubing, where cast-iron or steel may be used, will simply not rate at all. Again, the smaller liquid chlorine user may have to be content to accept chlorine in the form of hypochlorites for the duration of the pinch.

Secretary Jordan puts it well when he states that—"Water-works men should be loyally reminded that there is going on in the United States the most rapid and tremendous industrial expansion program that history has known. Things will fit together in time and every worth-while project and activity will get the treatment that it merits. This is the time for water-works men to demonstrate their fine patience and co-operation in the adjustment period."

Our readers can be certain that Jordan and his Defense Committee are looking to the interests of the water works man during this period of give and take. In the meantime, do not postpone filing O.P.M. Form P.D.-1 in application for a rating.

L. H. Enslow

2ND ANNUAL CONVENTION OF SEWAGE WORKS FEDERATION

Has Ear-Marks of Being "Bigger and Better" than Chicago Convention —Attendance of 800 Predicted for New York Convention

AFTER writing the "Bigger and Better" part of the above sub-title, it is realized that the "Bigger" part is O.K., but the "Better" part is going to be difficult to prove. Certainly all who attended the 1st Annual Convention of the Sewage Works Profession on a national scale, will agree that it was top-flight in respect to quality throughout. If the New York Convention equals the Chicago Convention in respect to technical program, entertainment and exhibits nobody will ask more.

However, all 1941 Convention Committees are out to have a "show" at Hotel Pennsylvania in New York City on October 9, 10 and 11, which will go Chicago one better; and, that can mean but one thing—a bang up Sewage Works Convention.

News concerning the success of the Chicago Convention having traveled far, it is with a reasonable degree of certainty that the predictions of a larger attendance than the 600 odd in Chicago last fall will be realized. Aside from the convention proper there is so much to do and see around New York, including the very modern and new treatment plants of New York City, and the numerous new and revamped plants in contiguous areas of New Jersey, that this opportunity should prove an added drawing card to swell the attendance.

In our last issue we mentioned the "Get-Together" planned for the New York Convention as the ice-breaking opening function. We mentioned this exceptional opportunity wherein *"Mr. Anybody"* can see and meet *"Mr. Everybody."* Well, isn't that one important reason for meetings and conventions? So, there will be a planned opportunity for those men who have long wanted the chance to meet and chat with some of the top-flight operators and engineers in the field to do so. A second opportunity of this nature will be during the smoker. Always has this writer remembered the first convention of national scope that he attended. The one thing that alone made the expense worth the sacrifice, in those early days of low operating salaries, was the opportunity of meeting the big men in the profession. And, a pleasure that has come since was in having met those who were just "little cogs" in the machine at the time, but who have gotten to be "fly-wheels" since.

So the above paragraph is directed especially to the small operator and the young engineer who may erroneously feel that he cannot afford the expense of attending the National Sewage Works Convention until it comes closer to home. Let us say that things are generally worth, to one, what he pays for them. And, spending money for opportunities should never be a questionable investment—particularly in the minds of the younger men with a future ahead of them. Attending the larger conventions spells opportunity—and, to many, it has meant advancement, recognition and a real return on what at the time seemed a considerable investment to be made out of hard saved earnings.

The Plant Operator Gets First Consideration

In organizing the Sewage Works Federation the key-note throughout was service to the plant operator. This same consideration held in setting up committees wherein specifications require that a definite number of places on each important committee be occupied by plant operators.

In building the program for the 2nd Annual Convention operators again have come in for first consideration. In consequence, the great majority of topics to be discussed will be presented by or for operators, with a minimum of research and engineering papers. The "Operator's Breakfast," and the Round-Table which will follow under the leadership of A. M. Rawn, chief engineer of the Los Angeles County Sanitation Districts, will be alone (if we know our man) worth the trip to New York.

There will be a symposium on the control and operation of various treatment processes, special topics being screenings, handling, biological filters, sludge digestion and record keeping. Contributing operators are Wellington Donaldson (New York), M. W. Tatlock (Ohio), G. E. Griffin (Conn.), A. H. Goodman (Ill.), with "Swede" Larson of Springfield, Ill., as the continuity man, doing a job as the "Swede" can do it.

Amongst other operating topics planned is one on "Sludge Gas Utilization in the Small Plant," by George Martin of Green Bay, Wis.; "Operation and Maintenance of Small Pumping Stations," by Grant Olewiler of Ardmore, Pa. Other papers being arranged for concern "Standards and Criteria of Sewage Plant Operation" and "The Relation of Design to Practical Operation."

"The Effect of Load Distribution on the Activated Sludge Process" is a topic to whet the appetite and curiosity of every operator and engineer having to do with this method of treatment. The discussion is to be led by Gordon M. Fair (Harvard) and is designed to bring forth active discussion concerning tapered aeration, sludge reaeration, and distribution of loading by progressive introduction of settled sewage into the aeration units, such as is practiced in New York City. In this discussion Richard H. Gould, responsible for the New York design, will participate as will several others having first hand experience with air-tapering for like purpose, and other means of loading control.

Sewage Works in the National Emergency

A key-note topic on the program is that on emergency preparedness and operation and maintenance of sewer systems and treatment works during the national defense program. Leader of this symposium is Warren J. Scott, State Sanitary Engineer of Connecticut, who is leaving no doors unopened.

Industrial wastes will have the attention of Milton P. Adams, Director of the productive Michigan Stream Control Commission, who will discuss "The Treatment and Control of Industrial Wastes."

Equipment and Materials Exhibits

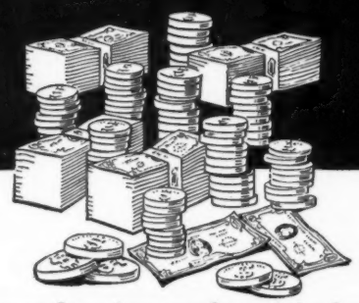
Always one of the most educational features of any convention are the manufacturers' exhibits of materials, equipment and processes, which can not be seen anywhere but at a national convention. The 1940 Chicago exhibits of 55 firms were exceptional. This year there will probably be an even greater number. One feature this year may be expected to be the exhibit of those materials which can be used to take the place of other materials which have become so difficult to procure because of demands for direct defense. Although water and sewage works have been accorded a preferential rating by Washington, in the allocation of materials needed in direct defense, it behooves every plant manager in both fields to post himself adequately on what materials may be used in place of certain other materials and equipment formerly employed. This, because the Office of Production Management is very likely for the time being to *insist* on procurement and utilization of materials which may be substituted for those on the scarcity or priority lists. Already this is in evidence and the manager applying for help from one of the District OPM offices, may be asked if he has considered other more readily procurable materials which are not under priority control or difficult to procure because of the temporary scarcity. On this score exhibits this year, as never before, should be studied closely.

In respect to manufacturers' exhibits at conventions, we heard a certain mayor remark—"I don't like for Bill (the Sup't) to go to the convention, because he always sees something new and comes back home and wants us to buy it for him."

Moral:—If you don't want to learn what's new or how to do your job better, then don't come to the New York Sewage Works Convention October 9-11th.

CASH PRIZES!

Tell us how you used Perchloron for emergency water purification



Here's a prize contest especially for superintendents and engineers of municipal water works. Twenty-five dollars ($25.00) will be paid by Penn Salt for each outstanding case history of emergency water purification with Perchloron. Five dollars ($5.00) will be paid for similar case histories not judged worthy of major prizes, but deserving recognition.

Send your entry . . . 500 words or less . . . today to Pennsylvania Salt Manufacturing Co., Widener Bldg., Phila., Pa. The contest closes on October 1, 1941.

A TYPICAL PERCHLORON CASE HISTORY

This is an outline of the sort of story that may win you a prize: The quality of a section of a city's public water supply was being questioned because of the positive presumptive B. Coli tests in one suburban section, despite the fact that negative samples only were obtained on the balance of the distribution system. Pollution was thought to be entering the main somewhere between the city proper and this suburb.

Pending location and correction of the source of the pollution, emergency disinfection was attained by continuously injecting a solution of Perchloron into this main. This was done by a conventional hypochlorite pressure feeding pump, which delivered the Perchloron solution into the main through an emergency tap. The quantity added was sufficient to attain the desired disinfecting residual after 20 minutes' contact, and the 16 miles of feeder main provided the desired retention period.

Thanks to Perchloron, this section was assured of a safe water supply until the source of pollution could be discovered and the trouble corrected.

Perchloron, dustless and dry, a free-flowing and readily dissolved powder containing more than 70% available chlorine, is also useful for sanitizing new mains, for clear wells and filters, and for swimming pool sanitation. Packed 9 handy-sized cans to the case, each can with airtight cover; also in 100-lb. drums. Write for the new handsomely illustrated booklet on Perchloron.

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MEETINGS SCHEDULED

Aug. 28-29—ABERDEEN, S. D. (Alonzo Ward Hotel)
South Dakota Water & Sewage Works Conference. Secretary, W. W. Towne, Pierre, S. D.

Sept. 1-3—STATE COLLEGE, PA. (Pa. State College)
Pennsylvania Water Works Operators' Association. Sec'y Treas., I. M. Glace, 22 South 22nd Street, Harrisburg, Pa.

Sept. 3-5—STATE COLLEGE, PA. (Pa. State College)
Pennsylvania Sewage Works Association. Sec'y-Treas., Bernard S. Bush, Kirby Health Center, Wilkes-Barre, Pa.

Sept. 11-12—GLENS FALLS, *N. Y.* (Hotel Queensbury).
New York Section A.W.W.A. (Fall Meeting). Secy-Treas., R. K. Blanchard, Neptune Meter Co., 50 West 50th St., New York, N. Y.

Sept. 16-17—CLEVELAND, OHIO. (Hotel Cleveland)
Ohio Conference on Water Purification. (25th Annual Meeting.) Secretary, T. R. Lathrop, State Department of Health, Columbus, Ohio.

Sept. 18-19—SANTE FE, NEW MEXICO (LaFonda Hotel)
Rocky Mountain Section A.W.W.A. Secretary, E. V. Howe, Sanitary Engineer, State Board of Health, Denver, Colo.

Sept. 18-19—MANSFIELD, OHIO (Mansfield-Leland Hotel)
Ohio Conference of Sewage Treatment. Secretary, B. M. McDill, Department of Health, Columbus, Ohio.

Sept. 19-20—PROVIDENCE, R. I. (Hotel Biltmore).
New England Sewage Works Association. (Annual Fall Meeting.) Sec'y-Treas., LeRoy W. VanKleeck, State Dept. of Health, Hartford, Conn.

Sept. 23-26—BOSTON, MASS. (Hotel Statler)
New England Water Works Association (Annual Convention). Secretary, Frank J. Gifford, 613 Statler Building, Boston, Mass.

Sept. 24-26—GRAND RAPIDS, MICH. (Hotel Pantlind)
Michigan Section A.W.W.A. Secretary, Maurice N. Gerardy, Department of Water Supply, Detroit, Michigan.

Sept. 26—CHESTER, PA.
Pennsylvania Water Works Operators' Association. (Sectional Meeting.) Secretary, I. M. Glace, 22 South 22nd St., Harrisburg, Pa.

Oct. 6-8—RACINE, WIS. (Hotel Racine)
Wisconsin Section A.W.W.A. Sec'y-Treas., Leon A. Smith, City Hall, Madison, Wis.

Oct. 9-11—MINNEAPOLIS, MINN. (Nicollet Hotel)
Minnesota Section A.W.W.A. Secretary, R. M. Finch, Wallace & Tiernan Co., Inc., 416 Flour Exchange, Minneapolis, Minn.

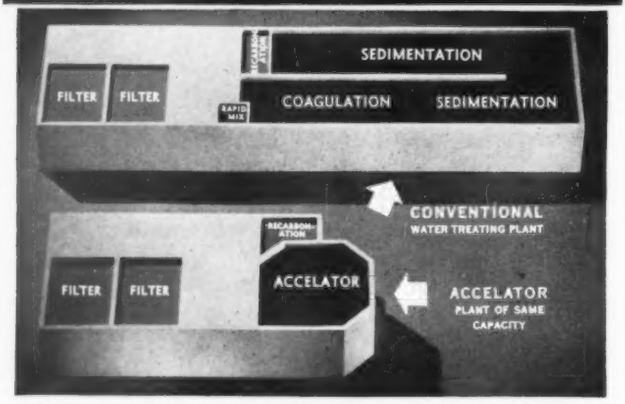
Oct. 9-11—NEW YORK, N. Y. (Hotel Pennsylvania)
Federation of Sewage Works Associations. Executive Secretary, W. H. Wisely, P. O. Box 18, Urbana, Ill.

Oct. 13-17—ATLANTIC CITY, N. J.
Conference of State Sanitary Engineers. Secretary, H. N. Old, U. S. Public Health Service, Washington, D. C.

Oct. 13-16—FORT WORTH, TEXAS (Texas Hotel)
Southwest Section A.W.W.A. Secretary, L. A. Quigley, Supt. City Water Works, Fort Worth, Texas.

Oct. 14-17—ATLANTIC CITY, N. J. (Convention Hall)
American Public Health Association (70th Annual Meeting). Executive-Secretary, Reginald M. Atwater, M.D., American Public Health Ass'n., 1790 Broadway, New York, N. Y.

Save WITH AN ACCELATOR



A space saving of 61% was possible in a recent water treating installation where an Accelator treating plant was used in preference to old style settling basins . . . The Accelator treats *faster*, delivers a better effluent, and *costs less to operate* than ordinary treating plants. Send today for the free bulletin, "The What, How and Why of the Accelator."

INFILCO INTERNATIONAL FILTER CO.
325 W. 25TH PLACE, CHICAGO, ILL.

Large Diameter
CAST IRON FITTINGS

(Below) Acipco 42" Ell
(Right) Acipco 42" Tee

Acipco produces a complete line of high-quality Cast Iron Fittings for use in pipe lines conveying either liquids or gases. Fittings for use in conveying liquids are furnished either with standard tar coating, or Enameline or Cement-Lined as required. Fittings for use in conveying gases are furnished unlined and are carefully *air-tested*.

AMERICAN CAST IRON PIPE CO.
BIRMINGHAM, ALA.
Dallas Houston El Paso Kansas City Los Angeles San Francisco
Chicago Minneapolis New York City Cleveland Pittsburgh

MEETINGS SCHEDULED

Oct. 15-17—ATLANTIC CITY, N. J. (Haddon Hall)
Pennsylvania Water Works Association. Secretary, Dr. F. Herbert Snow, 710 Telegraph Bldg., Harrisburg, Pa.

Oct. 16-18—ATLANTIC CITY, N. J.
New Jersey Section A.W.W.A. Secretary, C. B. Tygert, P. O. Box 187, Newark, N. J.

Oct. 16-17—KITCHENER, ONT. (Walper House)
The Canadian Institute on Sewage and Sanitation. Sec'y-Treas., Dr. A. E. Berry, Dept. of Health, Toronto, Ont.

Oct. 20-22—JAMESTOWN, N. D.
North Dakota Water & Sewage Works Conference. Secretary, Wm. J. Nordley, Edgeley, N. D.

Oct. 20-22—CEDAR RAPIDS, IOWA (Montrose Hotel)
Missouri Valley Section A.W.W.A. Secretary, Earl L. Waterman, Prof. of Sanitary Engineering, Univ. of Iowa, Iowa City, Ia.

Oct. 22-25—FRESNO, CALIF. (Hotel Fresno)
California Section A.W.W.A. Sec'y-Treas., G. E. Arnold, San Francisco Water Department, Millbrae, Calif.

Oct. 22-25—ATLANTA, GA. (Georgia Tech)
Annual Water & Sewage School of the Georgia Water & Sewage Association. Director of School, Prof. H. A. Wycoff, Georgia Tech. Ass'n Sec'y, Paul Weir, 1210 Hemphill Ave., Atlanta, Ga.

Oct. — —FORT WAYNE, IND.
Central States Sewage Works Association. Secretary, E. J. Beatty, State Board of Health, Madison, Wisc.

*Oct. 26-29—NEW ORLEANS, LA. (Roosevelt Hotel)
American Public Works Association. Executive Director, Norman Hebden, 1313 East 60th St., Chicago, Ill.

Oct. 27-29—NASHVILLE, TENN. (Andrew Jackson Hotel)
Kentucky-Tennessee Section A.W.W.A. Secretary H. D. Schmidt, Director Div. of Sanitary Engineering, Department of Health, Nashville, Tenn.

Oct. 30-Nov. 1—MORGANTOWN, W. VA. (Hotel Morgan)
West Virginia Section A.W.W.A. Secretary, J. B. Harrington, Assoc. Engr., State Department of Health, Charleston, W. Va.

Oct. 30-31—ROANOKE, VA. (Hotel Roanoke)
Virginia Section A.W.W.A. Secretary, Norman Phillips, Ass't San. Engr., State Dept. of Health, 119 State Office Bldg., Richmond, Va.

Nov. 3-4—PITTSBURGH, PA. (Wm. Penn Hotel)
Engineering Society of Western Pennsylvania (Water Conference). Chairman, H. M. Olson, 171 Longue Vue Drive, Mt. Lebanon, Pittsburgh, Pa.

Nov. 3-5—HIGH POINT, N. C. (Sheraton Hotel)
North Carolina Section A.W.W.A. and
North Carolina Sewage Works Association. Secretary, R. S. Phillips, Box 1170, Durham, N. C.

Nov. 6-7—BALTIMORE, MD.
Four States Section A.W.W.A. Secretary, Lloyd Nelson, U. S. Pipe and Foundry, Broad and Chestnut Streets, Philadelphia, Pa.

*(Change in dates from previous listing.)

OVER 700 Palmer Filter Bed Agitators NOW IN SERVICE . . .

A typical cross section of Palmer filter bed users. Why not ask the Supt. or operator of the plant nearest you just what they think of this equipment.

MR. C. E. PALMER
A practical water works man—inventor of the Palmer filter bed agitator

Aberdeen Proving Ground—Aberdeen, Md.
Akron, Ohio
Allentown, Pennsylvania
American Enka Corp.—Enka, North Carolina
American Writing Paper Corp.—Holyoke, Mass.
Anheuser-Busch, Inc.—St. Louis, Missouri
Appleton, Wisconsin
Avon, Ohio
Baldwin Filtration Plant—Cleveland, Ohio
Beaver Valley Water Co.—Beaver Falls, Pa.
Bogota, Colombia, South America
Buffalo, New York
Charlotte, North Carolina
Chester, Pennsylvania
Citizens Water Company—Scottdale, Pa.
Cobleskill, New York
Columbus, Ohio
Concord, North Carolina
Consol. Water Power & Paper Co., Wis. Rapids, Wis.
Cornell University—Ithaca, New York
Del-Mar-Va. Power Company—Vienna, Md.
Detroit, Michigan
DuPont, E. I., de Nemours & Co.—Charlestown, Ind.; Buffalo, N. Y.; Belle, W. Va.
Eastern Corp.—South Brewer, Maine
East Chicago, Indiana
Ellwood City, Pennsylvania
Erie, Pennsylvania
Fayetteville, North Carolina
Fort Belvoir, Virginia
Fort Bragg, North Carolina
Fort Lauderdale, Florida
Fort Pierce, Florida
General Electric Company—Lynn, Massachusetts
Gulf State Utilities Co.—Baton Rouge, La.
Hamburg, New York
Hammermill Paper Company—Erie, Pa.
Huron, Ohio
Indianapolis, Indiana
Kankakee Ordnance Depot—Kankakee, Illinois
Kennett Square, Pennsylvania
Kensington Water Dept.—New Kensington, Pa.
Laurel, Maryland
Leominster, Massachusetts
Lynchburg, Virginia
Lyons, New York
Mahoning Valley Sanitary Dist.—Youngstown, O.
Milledgevi'le, Georgia
National Biscuit Company—Marseilles, Illinois
Nekoosa Edwards Paper Co.—Port Edward, Wis.
Newark, New York
New Bedford Rayon Co.—New Bedford, Mass.
Newport News, Virginia
N. Y. Central R.R. Systems—West Albany, N. Y.
N. Y. Electric and Gas Corp.—Dresden, N. Y.
N. Y. State Elec. & Gas Corp.—Geneva, N. Y.
Olean, New York
Ontario, New York
Orrville, Ohio
Pennsylvania Railroad Co.—Philadelphia, Pa.
Pennsylvania Water Co.—Wilkinsburg, Pa.
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Rayonier Paper Company—Hoaquiam, Wash.
Rochester & Lake Ontario Water Co., Rochester, N. Y.
Shenango Valley Water Co.—Sharon, Pa.
Staley Manufacturing Company—Decatur, Ill.
Statesville, North Carolina
Tarrytown, New York (Rockefeller Estate)
Thomasville, North Carolina
Tonawanda, New York
Troy, North Carolina
Union Electric Co. of Illinois—Venice, Ill.
Weiser, Idaho
W. Va. Pulp & Paper Co.—Covington, W. Va.
W. Va. Water Service Co.—Princeton, W. Va.
Wheeling, West Virginia
Williamson, New York
Worcester County Elec. Co.—Worcester, Mass.

The same Palmer filter wash system giving such good results elsewhere should do the same for you.

Activated Alum Corp.
Office: 5701 Pennington Ave., Baltimore, Md.
Works: Curtis Bay, Baltimore, Md.

The new "VAREC" approved Pressure Relief and Flame Trap Assembly, Fig. No. 440, is one of the many "VAREC" products described and illustrated in detail with flow charts, diagrams, and engineering data in the "VAREC" Sewage Gas Control and Safety Devices Catalog, S-3. A copy of this "Sanitation Engineers' By-word" is yours for the asking.

●

See the "VAREC" exhibit at the Second Annual Convention of the Federation of Sewage Associations, Hotel Pennsylvania, New York City, October 9 to 11, 1941.

●

THE VAPOR RECOVERY SYSTEMS COMPANY
2820 No. Alameda St., Compton, Calif.

Branch Offices
New York City Houston, Tex. Tulsa, Okla.
Agencies Everywhere

LITERATURE AND CATALOGS

The Biofiltration System—is the subject of a new and impressive 22 page bulletin from the Dorr Company, holders of patents covering this newest of modern methods of sewage and industrial waste treatment on rugged trickling filters, at rates of application and organic loadings which a few years ago would have been considered unbelievable. Facts cited as basic in the "Biofiltration" System of high-rate high-capacity filtration are: (1) dilution and freshening of sewage by effluent recirculation, also maintaining a desirable higher uniformity of liquid distribution over the stone beds; (2) increased aeration afforded by shallow stone beds, more effectively aerated by natural air circulation, or breathing.

Perhaps the most completely informative bulletin ever produced by The Dorr Co., this one gives all of the essentials required in designing or revamping plants to utilize the "Biofiltration" System. It presents flow sheets for the single stage system (for mild sewage); the two stage system of filters in series (for strong sewages and industrial wastes); and the three stage system (for the strongest industrial wastes). Typical plant layouts and very complete data are presented, from which actual design may be conducted with confidence. Operating data and costs are given, the last including comparative construction costs for the high capacity filters and appurtenances in comparison with other methods for secondary treatment. In listing the distinctive advantages of the "Biofiltration" method, attainable results and costs are compared with those of the standard trickling filter and standard activated sludge treatment. Leading advantages are installation costs 25 to 35 per cent under standard trickling filters (handling 1/10th the load per acre), and operating costs 30 to 40 per cent less. Relative to activated sludge, with installation costs about equal, operating costs are 30 to 50 per cent less. Ability to withstand punishment, cope with disruptive wastes, and handle varying seasonal loadings, are chief amongst technical advantages with the high-rate, high-capacity process applied to the time-proven rugged trickling filter. Concerning advantages of effluent recirculation, the bulletin points out that in general the higher the recirculation ratio (up to continuous filter application ratio of 100 mg./acre/day) the better the overall results. However, recirculation ratios recommended as best operating practice start at 1:1 for ordinary mild sewage and step up to 6:1 for wastes approaching 1,000 B.O.D. value. Economics of the "Biofiltration" method, in comparison with others, are discussed rather thoroughly and the last page of the bulletin lists the 56 plants now employing the process. For a copy of Bul. No. 7311 write The Dorr Co., 570 Lexington Ave., New York City.

New Handbook on Pool Sanitation—A comprehensive treatise on every phase of swimming pool sanitation has just been published by Mathieson Alkali Works, Inc., for free distribution. This 50 page booklet is of the nature of a handbook which discusses all modern methods of purifying the water of every type of swimming pool, from the small private pool to large natural bodies of water. It also gives directions for algae control, prevention of the spread of athlete's foot and other infectious diseases, control of pool-water alkalinity, the care of sand beaches, and other details of pool and locker-room sanitation. Methods of testing the pool water for residual chlorine and for pH, or alkalinity, are fully described. For a copy of this useful guide and handbook—"Keeping the Pool Safe and Sanitary"—write Mathieson Alkali Works, Inc., 60 East 42nd St., New York City.

"Principles of Sewage Treatment" is a new 128 page booklet published recently by the National Lime Association as a companion booklet to that on "Water Supply and Treatment" by C. P. Hoover, produced some time ago by the Association. "Principles of Sewage Treatment" is the work of Dr. Willem Rudolfs, Chief, Dep't of Water and Sewage Research, Rutgers University, who states in the foreword that the booklet is intended for those interested in learning more about the role played by biological agencies in sewage purification and the factors which affect the activities of organisms, while the small plant operator may fine some useful hints on plant operation and control. The booklet, effectively illustrated throughout, contains 10 chapters which deal with sources and composition of sewages; microbiology and stabilization of sewage; methods of treatment; sludge disposal; and chlorination. One chapter of 5 pages is devoted to plant operation and operating prob-

lems; another of 6 pages to methods of analysis and at the end is a useful glossary of terms used in sewage treatment. In compiling this booklet Dr. Rudolfs had the valued assistance of Dr. H. Heukelikian, H. W. Gehm and G. M. Ridenour, of his staff, in producing their worthy "Principles of Sewage Treatment." For a copy write the National Lime Association, 927 15th St., N. W., Washington, D. C.

Piping Pointers — came from Crane Co., taking the form of a folder containing sketches and descriptions of how pipe lines may be put together with the least possibility of damage to fittings, valves, pipe threads—also pocketbook and dispositions. Crane Co. points out that in these days, particularly, every avoided error means an important saving of time, money and materials; and every short-cut is important if it's the right sort of short cut. To help in this direction the Crane folder of pipe pointers picturizes methods and gives suggestions designed for training men in handling piping equipment and installing pipe lines and valves. This is the first of a series of such folders to be produced, and these quickly comprehended suggestions and sketches of the right and the wrong way should prove of value. If you would like a copy of "Pipe Pointers —No 1," and others to follow, just write Crane Co., 836 South Michigan Ave., Chicago.

Water and Sewage Chemistry and Chemicals—has come with compliments of the General Chemical Co. It is an interesting 14 pages of some of the ABC's of chemical terms, symbols and reactions taking place during the treatment of water and sewage. Then there is a listing and description of the more commonly used chemicals in treatment, which sets forth their specific characteristics, composition and reactions. A section relates laboratory procedures and methods of preparing standard solutions. The demand for this brochure which constitutes a reprinting of material from "Public Works" Magazine, we understand, has been high and it constitutes something worth writing for. Address General Chemical Co., 40 Rector St., New York City.

Buckets and Buckets—are presented in Hayward Co.'s new bulletin which describes and pictures many types and styles of material handling and digging buckets of the clam-shell and orange-peel design.

(Continued next page)

Cities profit 3 ways with a Royer!

Many municipalities owning from one to twelve Royer machines use them three ways, any one of which makes it a profitable, cost-cutting investment—especially in these times when labor is at a premium:

1 **SEWAGE TREATMENT PLANTS use the Royer to disintegrate sludge, reducing it to pea-size particles in demand by growers for building up soil and as top dressing. The Royer further dries sludge cake and removes sticks, stones and trash. Handles material with moisture content as high as 51%. Discharges into trucks or onto piles.**

2 **PARK BOARDS use the Royer to shred compost, sod and other materials for top dressing and to mix in lime, ammonium sulphate, manure, sewage sludge or other enrichening or sweetening materials. They're a boon to greenskeepers at municipal golf courses and to caretakers at municipal cemeteries.**

3 **SCHOOL BOARDS use the Royer to mix clay and cinders and other materials for tennis courts, running tracks, baseball diamonds, etc., and to maintain campus lawns and school grounds. Parks perform these same jobs where recreational facilities are under their jurisdiction.**

There are 12 portable and stationary Royer models for every capacity requirement—electric, gasoline and belt-to-tractor powered.

Pennsylvania city maintains playgrounds, stadium and park tennis courts and use their Royer to disintegrate sewage sludge as well, converting it from a nuisance into a readily marketed product.

THE ROYER

This Delaware city also uses their Royer to cut costs of shredding compost and sod for lawn top dressing.

ROYER FOUNDRY & MACHINE CO.
170 PRINGLE ST., KINGSTON, PA.

It Takes WATER TO WIN A WAR

FOR MEN, machines and materials there is no substitute for water. Every factory, city, air field, army camp or munition plant engaged in defense work should have an abundance of water—preferably from its own Well Water System. A water shortage or failure would play havoc with any production program.

In selecting a Well Water System you would first look to a firm that had a dependable reputation. It should have proven itself over a long period of time. Next, their product should be of unquestionable merit. All of these basic factors and many more are enjoyed by Layne—"The World's Largest Water Producers." The Nation-wide Layne organization has the men, equipment and skill to undertake and promptly complete any size water producing project, anywhere in the United States or possessions.

If you would like to have facts concerning your water supply needs, write to Layne. Their engineers are ready to cooperate. They are specialists in the water producing field. They know water bearing formations, well drilling and pump installation. For bulletins on Layne Well Water Supplies and Turbine Pumps, write

LAYNE & BOWLER, INC.
Memphis, Tenn.

LAYNE
PUMPS & WELL WATER SYSTEMS

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Layne-Arkansas Co.	Stuttgart, Ark.
Layne-Atlantic Co.	Norfolk, Va.
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Layne-Louisiana Co.	Lake Charles, La.
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Layne-Texas Co.	Houston, Texas.
Layne-Western Co.	Kansas City, Mo.
Layne-Western Co. of Minnesota	Minneapolis, Minn.
Layne-Bowler New England Corp.	Boston, Mass.
International Water Supply	London, Ontario, Can.

Especially interesting are the Dwarf Orange Peel Buckets. One is small enough to operate inside of a 12-inch pipe. The special Sewer Catch Basin Buckets are also of the orange-peel type and designed to hold liquids as well as muck. Incidentally this particular bucket available in three sizes is the subject of a special bulletin all of its own. Anyone interested in buckets will find Bulletin 630 worth requesting—also the special Catch Basin Bucket bulletin. Address The Hayward Co. (Dept. "S"), 50 Church St., New York City.

Crispin Air Valves—are too well known in the water works field to make necessary more than the word "Crispin." Strangely enough few know that these units are not manufactured by the Crispin Co., but rather by the Multiplex Mfg. Co., at East Berwick, Pa. The little catalog just received pictures and describes the operation of Crispin Air Release and Vacuum Prevention Valves for pipe lines, pressure tanks, etc. One of the most popular types is a combination Air Release and Vacuum Prevention unit. Specifications and sizes are tabulated, along with prices. One particularly "tricky" and interesting valve is the double ball unit for syphon lines to prevent accumulation of air released from the water at points of greatest negative head on the syphon, the second ball prevents loss of water after the air has been bled out. For a copy of "Crispin Air Valves" write Multiplex Mfg. Co. (Dept. H), East Berwick, Pa.

Open Steel Flooring—is the subject of a handbook just published by the Open Steel Flooring Institute, Inc. Designed for use by architects and engineers, this handbook treats of the uses and properties of open steel gratings for floors, stairs, walkways, ventilator shafts, and platforms. It describes and pictures the three principal types of steel floor grating—welded, riveted and interlocked—and cites the merits and applications of each type. The advantages of such gratings are cited and a variety of installations are pictured. A table of "Safe Loads" for gratings of various design dimensions is that taken from U. S. Government Specifications, reproduced in full. It contains names of the 8 member firms comprising the Institute. For a copy of "New Ideas in Functional Floor Design" write Open Steel Flooring Institute, Inc., (Dept. W.S.), American Bank Bldg., Pittsburgh, Pa.

CLOGGED PIPES
Made Good as New

THE NATIONAL METHOD OF WATER MAIN CLEANING makes your old pipe practically as good as new. Every department is subject to loss through the ravages of time upon its distribution system. The cleaning out of this foreign matter inevitably leads to increased pressure and flow, improved health conditions, and lowered operating costs.

Our illustrated Booklet, "The Cleaning of Water Mains," will be sent upon request.

NATIONAL WATER MAIN CLEANING CO.
30 Church Street, New York, N. Y.

BRANCH ADDRESSES
205 West Wacker Drive, Chicago, Ill.
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PITTSBURGH-DES MOINES

Steel Gasholders

Spherical or bullet types for efficient storage of digester gas under pressure in sewage treatment plants. Any size—any metal—designed to meet your specific requirements. An experienced P-DM engineer will gladly consult with you, without obligation.

PITTSBURGH · DES MOINES STEEL COMPANY
Pittsburgh, Pa. . . . 3418 Neville Island
Des Moines, Ia. . . . . 919 Tuttle Street

EQUIPMENT NEWS

"Tube-Loy," New Water Service Material (Introduced by Am. Smelting)

• At this especial time when it appears urgent to divert copper metal ordinarily going into the water works field into uses for national defense, the present-day problem of water works managers and designing engineers is to locate or specify the best obtainable substitute for copper tubing and red-brass pipe.

As if in answer to a prayer, American Smelting & Refining Co. have come forward with a new tubing for water lines and consumer services. The product, trade-named "Tube-Loy," is said to possess characteristics of both lead pipe and copper tubing. It is produced in two types—Type "A," for use where lead pipe has heretofore been employed; Type "K," for use where copper tubing has been or would be employed. Interesting is the fact that this large producer of lead is suggesting substitution of "Tube-Loy" for the heaviest weight lead pipe as well as copper tubing.

"Tube-Loy" is an alloyed lead product (containing tin and small particles of calcium and magnesium) which possess greater strength than good grade lead, a lower rate of creep and greater ductility, while retaining all of the corrosive resistance qualities of pure lead and the strength of copper tubing. From the new alloy tubing is produced by the economical and exact process of extrusion, which results in uniformity of texture and wall thickness throughout.

Increased strength of "Tube-Loy" permits the production of tubing of much thinner wall thickness and weight per part than is permissible with pure lead, and at a lower cost per foot to users of AA as well as the heavier walled AAA lead pipe.

For substituting for either weight of lead service pipe Type A "Tube-Loy" is recommended, the need for stocking the single grade being a distinct advantage. It also comes in longer lengths than lead pipe, weighs less and, because of its greater ductility, is more easily handled. Joints may be made by the solder wiping method, or with fittings of the flare or sweat type.

Type K tubing has been produced to serve where Type K copper tubing has been customarily employed. It is of even lighter weight (wall thickness less) than the Type A tubing, but has demonstrated its utility for all service pressures up to 125 pounds. In sizes up to and including the 1 inch size it is said to cost less per foot than Type K copper tubing. It is produced in longer lengths than any other water service tubing and, being less rigid, is more easily uncoiled. Like Type A

(*Continued next page*)

SIMPLEX

for ACCURACY • RELIABILITY SOUND ENGINEERING IN FILTRATION PLANT EQUIPMENT

THESE factors — Accuracy, Reliability, Sound Engineering — have resulted in the past forty years in the installation of Simplex Rate of flow Controllers, Gauges, Venturi Meters in the world's finest filtration plants.

First to develop the Direct-acting Controller, the Master Control, the Bell-shaped Float, and the Sand Expansion Indicator, the cardinal policy of Simplex is to increase its usefulness to the waterworks profession by continued research, design and cooperative measures with both designing and operating engineers.

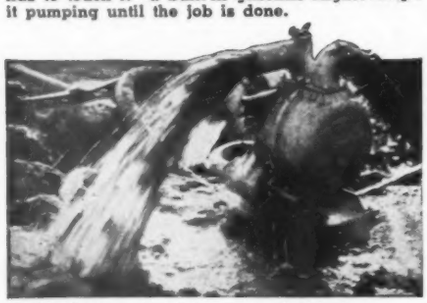
SIMPLEX PLEDGES ITS ENTIRE FACILITIES TO MEET THE DIVERSE PROBLEMS OF THE NATIONAL EMERGENCY.

Simplex Valve & Meter Company
68TH & UPLAND STS.
PHILADELPHIA

WHEN YOU WANT
PUMPING
WITHOUT
DELAY

And without manual labor—

A Homelite Portable Pump is your best bet. Easily portable—only 91 pounds complete—this pump is set up quickly by one man. It is fast self-priming. Pumps 15,000 gallons per hour—handles seepage automatically. And nobody has to touch it—a built-in gasoline engine keeps it pumping until the job is done.



And without trouble or maintenance

Pump sludge, sewage, muddy or sandy water with your Homelite. It handles 35% solids without clogging. There are no delays for cleaning. And your maintenance costs are practically negligible. A Homelite is built-in for extremely rugged service.

Send for new bulletin showing all Homelite Pumps

HOMELITE CORPORATION

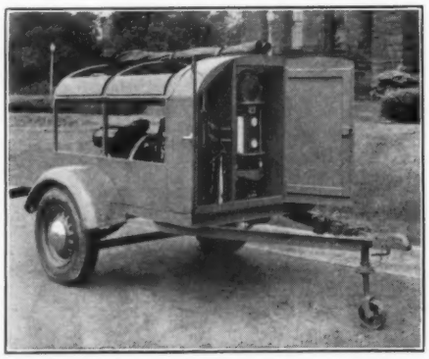
2508 Riverdale Ave. Port Chester, N. Y.

tubing, joints may be made by wiping or with flare or sweat type fittings.

The manufacturers point out that creep resistance, the measure of a metal to withstand load without thinning out, is actually 10 times as great for "Tube-Loy" as it is for the best quality lead.

A descriptive folder, of considerable interest, invites inquiries from those desiring pertinent facts and actual performance records of the new "Tube-Loy" which has been under development and in actual field use during several years of study and close observation. For a copy of the "Tube-Loy" folder and additional information write American Smelting & Refining Co. (Lead Products Div.), 120 Broadway, New York, N. Y.

New Mobile Chlorinator for Emergency and General Service



• A trailer type mobile chlorinating unit, designed to provide positive protection of water supplies under emergency conditions or to meet other temporary needs for chlorination, has been introduced by Wallace & Tiernan Co., Inc., Newark, N. J.

The unit provides for closely controlled solution feed of chlorine over a wide range of application rates. Especially designed, of particularly rugged construction, the chlorinator employs the well known W&T vacuum principle. Powered by a 5 h.p. gasoline engine mounted on the trailer, a self-priming pump will deliver the required injector water at sufficient pressure to apply 100 lbs. of chlorine per day against a maximum pressure of 100 lbs. per sq. in. in the main. Two 150 lb. chlorine cylinders are cradled in the trailer, connected in manifold to assure continuity of supply. The chlorinator is equipped with a complete set of accessories including corporation cocks, hose, tubing and fittings for emergency use in connecting to mains, and with all the necessary tools for the work. A comparator for making tests of chlorine residuals has a self-contained light source for use at night.

In the light of considerable data and information from British sources, this unit has been designed to meet emergency conditions as found in English experience during the past two years. It is designed to maintain accuracy of

(Continued next page)

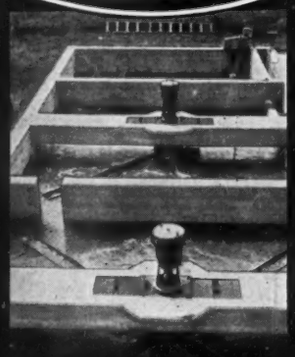
WITH THIS COMPOUND

PIPE JOINTING TROUBLES *FADE* AWAY

Tegul-MINERALEAD requires no skilled labor, caulking or deep bell holes • The work is speeded since initial leakage seals almost at once, permitting immediate back-filling and clearing up of the premises • Also, there are no delays when melting pot needs replenishing • Joints are permanently tight and withstand far greater vibration and thermal and mechanical shock than they'll ever meet in service • Write for more information about this *different, ingot form* bell and spigot jointing compound. The ATLAS MINERAL Products Company of Pa., Mertztown, Pennsylvania.

Tegul- MINERALEAD

AER·O·MIX
AERATOR – MIXER



Down-Draft Type MECHANICAL SEWAGE AERATORS

Write for information on AER-O-MIX for your SEWAGE or WATER TREATMENT APPLICATION.

VOGT MFG. CO.
INCORPORATED
P. O. Box 1122 Louisville, Ky.

operation despite transport over long distances or rough roads. Gross weight complete including two 150 lb. chlorine cylinders is 2150 lbs. It was expected that the new Emergency Chlorination Trailer, shown for the first time at the Toronto Convention of A.W.W.A., will have an important place in water supply protection plans and will serve as well for normal operation in main sterilization, secondary chlorination of reservoirs, dead-end flushing and other applications requiring a moble unit. Temporary increased chlorination needs of sewage treatment plants constitute another expected point of service.

For complete information on the new Emergency Chlorination Trailer, write Wallace & Tiernan Co., Inc., P. O. Box 178, Newark, N. J.

Rensselaer Features "Sorbo-Mat" Iron

● Rensselaer Valve Co. has adopted "Sorbo-Mat" Iron as standard for valve and hydrant castings, having been licensed by Sorbo-Mat engineers to use the improved method of producing this special cast-iron. As we understand it, Rensselaer has been given exclusive rights to produce and use "Sorbo-Mat" Iron for valves and hydrants produced for the water and sewage works field.

"Sorbo-Mat" Iron is chemically no different from any good grade of cast-iron, the difference being wholly a physical or structural difference brought about by controlled metallurgical reactions within the furnace and the use of selected raw materials. The process employed produces a high percentage of "Sorbite" (an iron-carbon compound) which results in a refined matrix structure — hence the abbreviated name "Sorbo-Mat," for Sorbite and Matrix.

The advantage gained is a molten metal which produces castings of markedly dense structure devoid of porosity. The resulting fine grain of the casting makes for toughness, density, uniformity of strength and greater resistance to corrosion.

Under the microscope the graphite of "Sorbo-Mat" Iron is seen in short, fine crimpy particles entirely surrounded by iron. In contrast the graphite in ordinary cast-iron is in large flakes. It is this structural homogeneity which is assumed to be responsible for resistance of the improved cast-iron to attack by corrosive elements as well as its marked density and toughness.

Rensselaer Valve Co. has in printed form the complete story of "Sorbo-Mat" Iron. If interested in the technical details write the company at Troy, N. Y.

New Bill Receipting and Check Writing Machine

● A new desk model machine just announced by Burroughs brings increased protection, speed, and economy to bill receipting and check writing and signing.

The operator merely slides the check or bill into the chute, indexes the amount on the keyboard, and depresses the motor bar, the machine automatically writing the date or consecutive

number, safeguarding the amount, accumulating the amount in a locked-in total, and signing the form with an authorized signature.

Both the signature die and the accumulated total figures are under lock and key, and the machine itself can be completely locked to prevent its use by an unauthorized person.

The illustration shows the new Burroughs receipting and check writing machine in use in the Wayne County (Mich.) Treasurer's Office for signing and receipting tax bills.

For further information, write to Mechanical Methods Division, Burroughs Adding Machine Co., Detroit, Michigan.

Reilly

Primer and Pipe Enamel

Courtesy Chicago Bridge and Iron Co., Fabricators of Steel Pipe

PROTECT NEW CHICAGO WATERLINES

In its construction of water mains and pipe lines, the City of Chicago builds for permanence with steel pipe protected by coatings of Reilly Primer and Pipe Enamel . . . These coatings bond firmly to the metal and are strongly resistant to abrasion. They withstand wide temperature variations without sagging in summer heat, or cracking in winter cold. When used on interior surfaces they effectively prevent tuberculation and assist in maintaining maximum flow over a long period of years. Complete information will be mailed on request.

REILLY TAR & CHEMICAL CORPORATION

Executive Offices: Merchants Bank Building, Indianapolis, Indiana

2513 S. DAMEN AVENUE, CHICAGO, ILLINOIS 500 FIFTH AVENUE, NEW YORK, N. Y. ST. LOUIS PARK, MINNEAPOLIS, MINN.

FIFTEEN · PLANTS · TO · SERVE · YOU

THE MODERN
TREND
IS TO DRESSER COUPLINGS

The long list of Dresser users includes cities such as:

Only Dresser Pipe Couplings give you "all four":

1. Simplicity
2. Speed
3. Flexibility
4. Tightness

Chicago, Ill.
Philadelphia, Pa.
Detroit, Mich.
Cleveland, O.
St. Louis, Mo.
Boston, Mass.
Pittsburgh, Pa.
San Francisco, Cal.
Washington, D. C.
Milwaukee, Wis.
Buffalo, N. Y.
Cincinnati, O.
Newark, N. J.
Kansas City, Mo.
Seattle, Wash.
Houston, Texas
Rochester, N. Y.
Portland, Ore.
Toledo, O.
Denver, Colo.
Birmingham, Ala.
St. Paul, Minn.
Syracuse, N. Y.
Omaha, Neb.

DRESSER
MANUFACTURING CO.
830 Fisher Ave. Bradford, Pa.

HYDRO-TITE

ONE POUND does the work of four pounds of lead. Much easier to use than lead and requires no caulking.

HYDRO-TITE joints are strong, very flexible and tight.

Write for our free trial offer.

HYDRAULIC DEVELOPMENT CORPORATION
MAIN SALES OFFICE - 90 CHURCH STREET, NEW YORK
GENERAL OFFICES AND WORKS - WEST MEDFORD STATION BOSTON, MASS.

OVER 25 YEARS WITHOUT A FAILURE

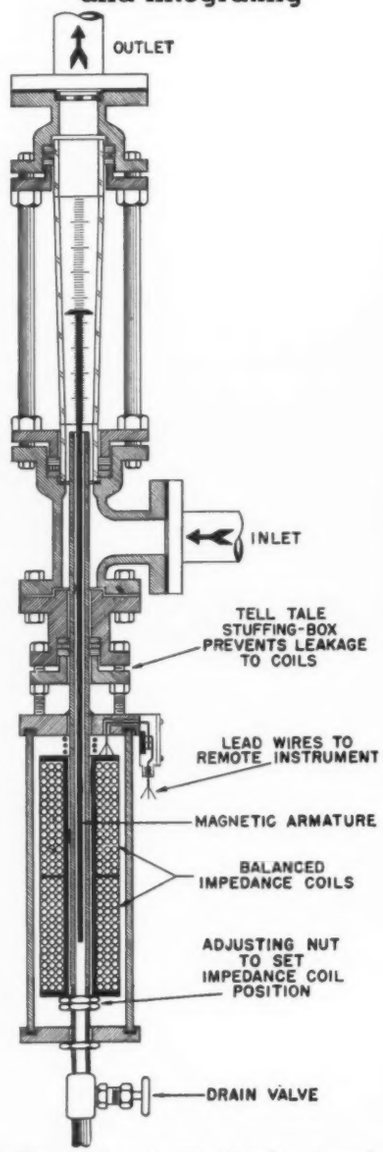
Aluminum Paint Substitute

● The American-Marietta Co., of Chicago, one of the oldest and most important manufacturers in the aluminum paint field, is meeting the aluminum shortage problem with five new protective coating items to take the place of non-procurable aluminum paints.

Known as the "Defense Line" one of the new products is said to be somewhat revolutionary. It is a vehicle containing metallic lead in place of aluminum and is suitable for most uses to which aluminum paints have been put.

For further information on the new Metal Lead Paint and the four other paints or coatings, write American-Marietta Co., 43 East Ohio St., Chicago, Ill.

"Rotameters" Now Recording and Integrating



● The "Rotameter" which has been becoming increasingly employed in the water and sewage fields for indicating flow of water, gas, air or chlorine has long been used in the industrial field. The meter proper, consisting of a vertical and slightly conical walled cali-

(*Continued next page*)

IF

Your SEWAGE effluents are high in suspended solids;

Or, you have a WATER PROBLEM;

Or, desire to RECOVER a product now wasted;

Or, you are disturbed by STREAM POLLUTION;

Or, are in any way interested in the removal of suspended solids from liquors;

You should investigate the

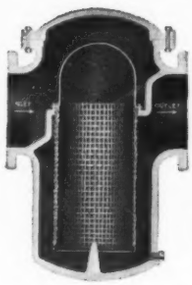
Laughlin Modified Rapid Sand Filter

BECAUSE, it is a simple automatic, continuous flow apparatus, designed on familiar lines, to accomplish a purpose without adding to the operator's troubles.

LAUGHLIN EQUIPMENT CORPORATION
270 Madison Ave., New York City

See page 73 of our new 96-page catalog for information on this

WATER STRAINER



Clean water at all times, without silt, leaves or any other foreign matter, is obtained with this Strainer, furnished with a strainer basket of any desired mesh. The strainer basket is always supplied oversize, to reduce the need for frequent cleaning. Also, it is possible to install the strainers in parallel formation, so that either unit may be in service while the other is being cleaned—thus avoiding any shutdown or delay.

GOLDEN-ANDERSON VALVE SPECIALTY CO.
Fulton Building Pittsburgh, Pa.

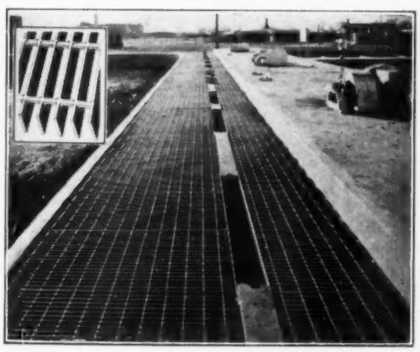
brated and etched glass tube with a spinning top-shaped float buoyed in the up-flowing stream, indicating the rate of flow, has previously been described in this section.

Now the announcement is made by Fischer and Porter Co. of Hatboro, Pa. that the heretofore indicating "Rotameter" has been combined with a system for electrical transmission of flow rates to indicating, recording and integrating instruments for nearby or remote locations.

The heart of the "Remote Indicating, Recording and Integrating Rotameter" is the "Stabl-Temp" induction coil, within which the magnetic armature rod attached to the indicating (floating) rotor in the meter tube above, moves up or down with flow changes. The coil and the rod connected to the rotor are shown clearly in the accompanying diagrammatic illustration. The special coil derives its name "Stabl-Temp" from the fact that its accuracy is stable, and assured, in spite of temperature variations which normally affect resistances of ordinary transmitter coil windings. The system of transmission employed is the well known null-balance induction bridge system.

For a more detailed description and clearer understanding of this new metering device for liquids or gases the reader should examine Bulletin 50-A. For a copy, write Fischer and Porter Co., 54 Country Line Road, Hatboro, Pa.

New Type Improved Grating



● The accompanying cut reveals a new type of welded steel grating at a sewage treatment plant. It has been developed by Wm. F. Klemp Company of Chicago.

Representing an advance in ruggedness and neatness of design, the new grating boasts strength and non-slip construction. It is rigid, self-cleansing, easily washed or painted, and permits maximum passage of light and air.

In design, the new Klemp Welded Steel Gratings feature the use of hot-rolled hexagonal steel bars which tie together the flat bearing bars set on edge. The hexagonal cross rods are sunk flush by electro-welding under extreme pressure—see detail inset in cut. While all joints are perfectly smooth, the narrow bearing bars and upper angle of the hex cross-rods produce the non-slip and non-vibrating walking surface.

(Continued next page)

JUST A FEW

BUILDERS

FIRSTS!

BUILDERS made:

The ***first*** commercial Venturi Tube
The ***first*** Venturi Registering Instrument
The ***first*** Venturi Meter for Sewage
The ***first*** Venturi Rate of Flow Controller
The ***first*** Venturi Controlled Chemical Feed Proportioner
The ***first*** Differential Loss of Head Gauge with Stationary Dial
The ***first*** Air Transmission System for Actuating Venturi Instruments
The ***first*** Time Impulse Telemetering Eystem for Flow and Level

Descriptive Bulletins covering meters and controllers available.

BUILDERS - PROVIDENCE, INC.
(DIVISION OF BUILDERS IRON FOUNDRY)
PROVIDENCE . . . RHODE ISLAND

SCHRAMM AIR COMPRESSORS

SCHRAMM model 105 Compressor on Pneumatic Tires. THE MODERN COMPRESSOR FOR—Paving breaking—Clay spade or trench digging—Backfill tamping—Rock drilling—Caulking pipe joints and Sheet Pile driving.

Write for Illustrated Catalog No. 42-P.

SCHRAMM, Inc., WEST CHESTER, PA.

PREPARE FOR EMERGENCIES WITH

M H

VALVES
HYDRANTS
AND WATERWORKS ACCESSORIES

SQUARE BOTTOM GATE VALVES
TAPPING VALVES
WALL CASTINGS
SPECIAL CASTINGS
TAPPING SLEEVES
CHECK VALVES
FLOOR STANDS
EXTENSION STEMS
SHEAR GATES
MUD VALVES
VALVE BOXES
FLAP VALVES
SLUDGE SHOES
FLANGE AND FLARE FITTINGS
FLANGED FITTINGS
B & S FITTINGS
CUTTING-IN TEES

Write for Catalog No. 34

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA

A simple but effective method of cleaning sand filters with ESOTOO*—tested and proved successful in actual operation—is fully explained in new bulletin "A Method of Cleaning Filter Beds with Sulfur Dioxide."

Isn't it worth your consideration? Write today.

V VIRGINIA

*"ESOTOO" is Virginia's Trade Name for Liquid Sulfur Dioxide.

VIRGINIA SMELTING
COMPANY
WEST NORFOLK, VIRGINIA

Standard Klemp Grating is fabricated with main bars on 1 3/16" centers, and the hex cross-bars on 4" centers. Panels of 24" width in 35 ft. lengths are standard, with odd width panels furnished to fill out desired dimensions.

An illustrated bulletin, which includes a "Safe Load Table" revealing bearing depths and bar thickness to meet various requirements, may be had by writing Wm. F. Klemp Company, 6611 South Melvina Ave., Chicago, Ill.

New Tachometer of Many Uses

• For use in measuring revolutions per minute, feet per hour, gallons per minute in any plant where rotating equipment is used, a new alternating current tachometer is announced by Westinghouse.

Known as Type A-80, the tachometer consists of an alternating current generator and a voltmeter of the rectifier type. No brushes or commutator are used in the generator which is of the permanent magnet, a-c inductor type.

The rotating element consists of laminated iron keyed to a rust resisting steel shaft. Laminations are slotted to permit variation of the air gap reluctance when the shaft is rotated. This in turn varies the flux linking the voltage coils and induces an alternating voltage in the coils. The alternating voltage is rectified by a Rectox unit in the voltmeter calibrated in rpm, feet per hour, or other units depending on the application. Overall acuracy is 0.5% at full scale.

For an illustrated bulletin presenting the Type A-80 Tachometer, write Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Synthetic Resins Superior Paint Basis

• The Du Pont Co., in a recent leaflet discusses the life of paints and enamels used on machinery, engines, pumps, etc., and cites the superiority of synthetic resin paints over oil or varnish type paints and enamels for use on machinery.

While varnish type paints suffer deterioration due to contact with oil and grease, temperature variations and abrasions, synthetic resin base paints remain unaffected by oils and grease, and take a lot of punishment otherwise, such as high temperatures.

Self-Propelling "Go-Getter"
SEWER CLEANER
TURBINE SEWER MACH. CO.
5210 W. State St., Milwaukee
276 Lafayette St. New York, N. Y

LEADITE
The Pioneer Self-Caulking Material for C.I. Pipe

W N S E

USED MOST EVERYWHERE!

Hundreds of water works men have used Leadite . . . saved with Leadite . . . proved the dependability of Leadite under most all conditions of bell and spigot water main construction.

THE LEADITE COMPANY
Girard Trust Co. Bldg., Philadelphia, Pa.

No Caulking

WITH THE MANUFACTURERS

Clarke Cassidy Elected President of Niagara Alkali

J. Clarke Cassidy

● J. Clarke Cassidy, for many years Works Manager of Niagara Alkali Co. and Electro Bleaching Gas Co., has been elected president of Niagara Alkali Company, which, by a recent union, now includes the Electro Bleaching Gas Co. At the same time, Mr. E. D. Kingsley was elected Chairman of the Board, while Mr. S. W. Jacobs and Mr. S. J. White continue as vice-presidents.

Mr. Cassidy brings to the position of president long and valuable experience in both the production and management ends of the business, which is the manufacture of caustic soda, caustic potash, carbonate of potash, paradichlorobenzene and EBG Liquid Chlorine. Many of the pioneering steps taken by the company in introducing these products and adapting them to new uses have been brought about with the cooperation of Mr. Cassidy as Works Manager. Before coming to Niagara in 1920, Mr. Cassidy had several years' of experience in the engineering and operating departments of the Aetna Explosives Co. and the Calco Chemical Co. He is a graduate of Columbia University with the degree of Civil Engineer.

"Bart" Marshall Made Division Sales Manager by Chain-Belt

J. W. Snavely Transferred from Houston to Milwaukee

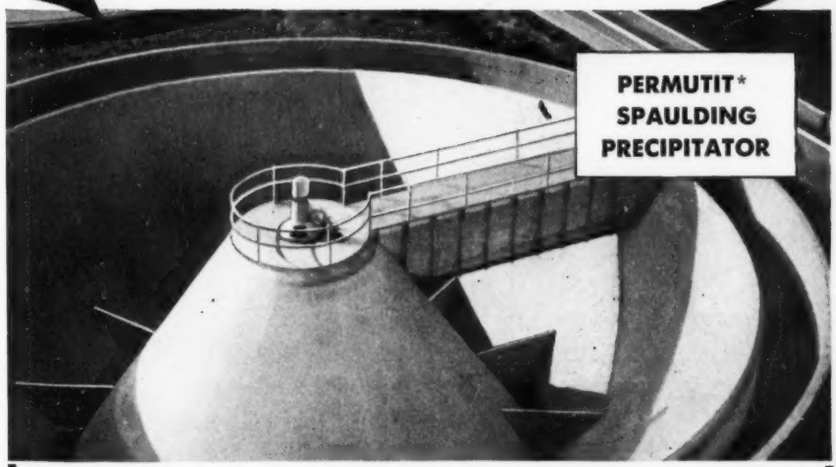
"Bart" Marshall

● W. B. Marshall who has been Assistant Sales Manager of the Conveying and Engineering Products Division of Chain Belt Co. has been recently made sales Manager of that Division.

Mr. Marshall has been with the company since 1920. Besides being Assistant Sales Manager, he has been in charge of the development and sales of Sanitation Equipment and has also been active in field sales work. Mr. Marshall graduated from Sheffield Scientific School of Yale University in 1921.

(Continued next page)

HERE'S
SOFT, CLEAR WATER
FOR YOUR COMMUNITY



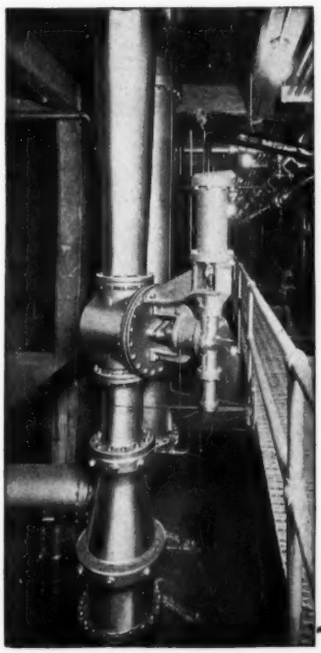
More practical, more economical, this modern cold lime "Precipitator" treatment puts soft, sparkling water within reach of every community. Plants now operating at capacities up to 120,000,000 gallons daily. Write for free booklets, or get Permutit's expert advice about *any* water problem. The Permutit Company, Dept. G1, 330 West 42nd Street, New York, N. Y.

* Trademark Reg. U. S. Pat. Off.

PERMUTIT WATER CONDITIONING HEADQUARTERS

Which Primary Element?

VENTURI TUBE, FLUME, WEIR,
ORIFICE, OR NOZZLE



The primary element for your metering application should be selected not arbitrarily but by the requirements to be fulfilled and by the economic considerations entering into the installation.

Sewage and sludge are often, though not always, measured by Venturi Tubes, Flumes, or Weirs.

Water may be satisfactorily measured by any type of primary element. Factors such as the cost of pumping, the pressure and the size of pipe or channel usually dictate the device used.

Steam is usually measured by the Bailey Orifice or Flow Nozzle.

Bailey Meter Company holds no brief for any particular primary element, its only interest is in making sure that the user secures the highest accuracy and reliability at the lowest expense.

Detailed information on the advantages of various types of primary elements furnished on request.

MU-18

BAILEY METER COMPANY
1072 IVANHOE RD., CLEVELAND, O.
Bailey Meter Company Limited, Montreal, Canada

ROSS

AUTOMATIC VALVES

Reducing	Combination
Relief	Surge
Altitude	Float
Back Pressure	Differential

ALTITUDE VALVE
for
Control of elevation and heads into and out of tanks, basins and reservoirs.

ROSS VALVE MFG. CO., Inc.
P. O. Box 595 Troy, N. Y.

"Sealdport" Lubrication in **NORDSTROM VALVES** *Assures*

POSITIVE CONTROL

in Sewage Disposal Plants

The Nordstrom method of "Sealdport" lubrication assures positive valve operation and control on sewage disposal plant lines. Nordstrom lubricant, under high pressure, is forced between the plug and body, making the valve leak resistant and freeing the plug to assure easy operation. By simply turning a screw at the top of the valve, both seat and plug surfaces are covered with a film of lubricant and a perfect seal is effected. Nordstrom Lubricated Valves have proven that they will outlive the average valve several times over on sewage disposal services.

MERCO NORDSTROM VALVE COMPANY
PITTSBURGH EQUITABLE METER COMPANY

J. Walter Snavely, district manager in the Houston territory for seven years, has returned to the Sales Department of the Conveying and Engineering Products Division at Milwaukee. Mr. Snavely graduated from the University of Wisconsin and entered the employ of Chain-Belt Company as a student apprentice in the year 1927.

Everett Jones Becomes General Manager of Simplex

"Casey" Jones

● We don't know exactly when it happened, but amongst the cards found on our desk is one of particular interest.

It reads—

Everett M. Jones
General Manager,
Simplex Valve & Meter Co.,
Philadelphia.

This boost up the ladder has apparently come to Mr. Jones since the Toronto A.W.W.A. Convention.

Known to his many friends as "Casey," Mr. Jones is believed to be the youngest General Manager in the water works and sewerage manufacturing field. His rise to such an important position in his company has been rather spectacular. As young as he was, he was given an unusual opportunity when made Sales Manager by Simplex about 6 years ago. His record in handling this important job during the depression years and since has been fittingly and deservedly recognized in the recent promotion.

A note on the card states that he will continue in direct charge of sales in addition to his new duties.

Honk! Honk! It's That WTCO Man

● In these days when visitors at water and sewage plants are being scrutinized with an eagle eye by guards and gatemen, Ed Rothman, Connecticut representative of Wallace & Tiernan Co, Inc., has a convincing way of identifying himself and his business. The license plates on his car carry the letters "WTCO," and it's a rare water works or sewage plant employee who doesn't know what that stands for.

(Continued next page)

PALCO
Reg. U. S. Pat. Off.
PACKING

Long service records on pumps and valves in water supply and sewage pumping stations all over the country testify to the exceptionally satisfactory service assured by PALCO*. Thoroughly lubricated in every strand *before braiding*. Free working sample on request.

GREENE, TWEED & CO.
Manufacturers of PALMETTO* and other self-lubricating packings
Bronx Blvd. at 238th St., New York City

EDSON'S NEW HAND PUMP

Smallest Diaphragm Pump Made, 2" Suction Open Discharge. Capacity 1400 G.P.H. Weight 50 lbs.

THE EDSON CORP'N
49 "D" Street
So. Boston, Mass.
NEW YORK: 142 Ashland Pl., Brooklyn
CHICAGO: 1961 Peoples Gas Building

Catalog "T" Gives Full Data, Also Edson Hand and Power Pumps, Suction Hose and Pump Accessories

CAST IRON PIPE

The Standard Material

for

Underground Mains

THE CAST IRON PIPE RESEARCH ASSOCIATION

Thomas F. Wolfe, Research Engineer
1015 Peoples Gas Bldg. Chicago, Ill.

ANTHRAFILT

A Filter Medium For All Purposes

ANTHRACITE EQUIPMENT CORP.
19 Rector St. New York

H. G. Turner Research Engineer
STATE COLLEGE, PA.

[Incidentally, the State of Connecticut limits the distribution of these initialled plates to drivers with a clean safety record . . . another feather in Ed Rothman's cap, in addition to the fact that his record at "WTCO's home office shows that his sales record is in a class with his driving record.—Ed.]

Clarence E. Kennedy Is Dead

● Clarence E. Kennedy, vice president in charge of sales of the Kennedy Valve Mfg., Co. of Elmira, N. Y., died on July 21st after an illness of eight months. He was 50 years old.

Mr. Kennedy was born in Brooklyn, N. Y., was graduated by Cornell University in 1912 and immediately entered the employ of the Kennedy Valve Mfg. Co., which was founded by his father, Daniel Kennedy. He saw the company grow vigorously during the twenty-nine years of his connection with it.

He leaves a widow, a son, William C., and four daughters; also his mother and two brothers, Matthew and John Kennedy, and three sisters.

Philadelphia Quartz Celebrates 110th Birthday

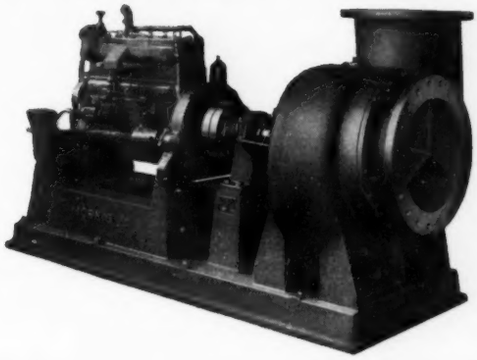
● Not very many businesses can look back 110 years to its beginning. On July 20th, however, Philadelphia Quartz Co. became 110 years old.

Not many know that Philadelphia Quartz Co. began as a soap and candle business when, on July 20th, 1831, Joseph Elkinton opened his unpretentious shop in which was sold bars of "Family Soap" produced in the back yard of the Elkinton home. Fame of this outstanding soap spread and the business grew into a national affair.

"Soluble Glass" came into the business when one of the two Elkinton boys just out of college began experimenting with it as a soap improver. The idea was a success and by 1860 the Elkintons were manufacturing sodium silicate and selling it to other soap manufacturers. Unique, at that time, was the service and assistance given to the user of the product manufactured. It marked the beginning of what became of giving to the user of silicates information and assistance which enables him to obtain maximum benefits from the products. By 1862 the tail was wagging dog in Elkinton & Sons establishment and the two sons in 1864 set up the Philadelphia Quartz Co., as a partnership to manufacture the new chemical silicate of soda. By 1904 manufacture of soap was discontinued and the Philadelphia Quartz Co. was incorporated. Starting with the one silicate, the company now produces over 33 silicates for a variety of uses.

An interesting side-light on Elkinton & Sons and Philadelphia Quartz Co. is the fact that in the 110 years since the back yard soap factory was set up in 1831, there have been only three generations of Elkintons directing the enterprise. At present, Thomas W. Elkinton, grandson of the founder, is president of the company.

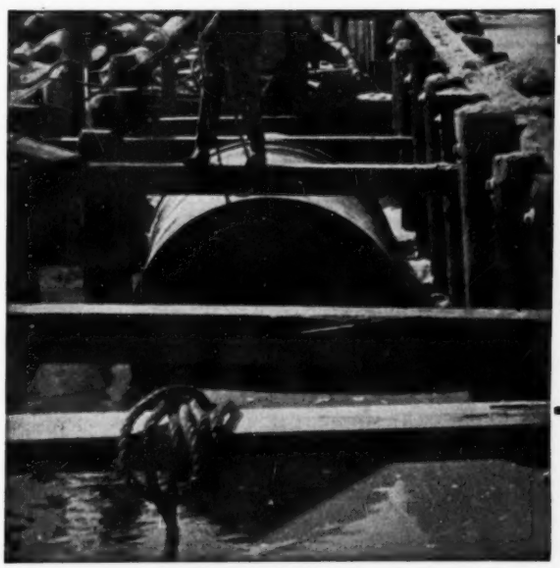
MORRIS CENTRIFUGAL PUMPS



for Sewage and Drainage

Morris Centrifugal Sewage and Drainage Pumps, like the Morris designs for water supply, are notable for their high efficiency; and in addition, have special features which assure non-clogging and trouble-free service. These designs are built both vertical and horizontal, and for standard or low-speed motors and other methods of drive. Full information on request.

MORRIS MACHINE WORKS . . . . BALDWINSVILLE, N. Y.



84" pipe—Spring Lake, N. J.

FLANGED PIPE
FLEXIBLE JOINT PIPE
BELL & SPIGOT PIPE
SPECIAL CASTINGS
SHORT BODY BELL & SPIGOT SPECIALS

Large stock enables us to make prompt shipments.

CAST IRON PIPE

SIZES 2" TO 84"

Warren Foundry & Pipe Corp.
11 Broadway, New York

Warren Pipe Company of Mass., Inc.
75 Federal St., Boston

TAPAX

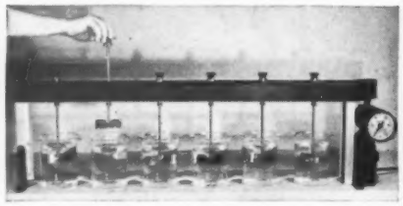
The ORIGINAL and FINEST....

Manhole Cushion U. S. Pat. No. 2,050,050 offers you the simplest solution for noisy, rattling covers. Easy to install. Lasting — Economical.

Write for story of Tapax and Trial Offer.

TAPAX MFG. CO., INC.
MAMARONECK NEW YORK

THE *Phipps & Bird* LABORATORY MIXER . . .



IS the important piece of equipment in the Modern Water Works Laboratory. Now being used by leaders in water works research. Many superintendents and chemists have been able to reduce their chemical costs by the control of chemical dosages with this mixer. Write for literature.

PHIPPS & BIRD, INC. Richmond, Va.

PHOENIX DISC WATER METERS

FEATURING

SPIRAL GEARS

(A Phoenix Patent)

Have an Excellent Record of Dependable — Accurate Service *Since 1914.*

Repair Parts for Water Meters

We furnish Parts for
UNION KING METERS
Send inquiries for prices.

PHOENIX METER CORP.
PRINCE BAY, S. I. NEW YORK, N. Y.

The Meter-Master

RATE RECORDER FOR WATER METERS

Send For Literature

F. S. BRAINARD & CO.
246 Palm Street, Hartford, Conn.

Peerless Pump Moves to Canton, Ohio

● The Peerless Pump Division of the Food Machinery Corp. has moved its Eastern offices and manufacturing facilities from Massillon, Ohio, to a new and modern plant in Canton, Ohio.

Peerless Pump's new Canton plant, necessitated by very substantial defense pump orders and steady increases in sales, makes available a total of approximately 55,000 square feet of floor space devoted to complete pump engineering, manufacturing, testing and sales, duplicating in great part and patterned after Peerless' new and modern plant at Los Angeles, Calif.

The building, of modern structural steel design, is completely air-conditioned for summer cooling and winter heating. Peerless Pump's entire line will be manufactured here, including turbine pumps, propeller type pumps, and the unique Peerless Hi-Lift.

The Canton plant comes under the same general management as the Los Angeles plant, Mr. Vernon Edler being vice president and general manager.

Wheelco Now Established in Own Building

● Wheelco Instrument Co., Chicago, manufacturers of a very complete line of indicating and control instruments with sales and service offices in 29 principal cities has just entered a third expansion program since the company began business in 1935.

The present expansion takes this young and vigorous company of rapid growth into its own impressive 6 story building, recently completed at Harrison and Peoria streets, Chicago.

In this connection we have just noted in an article in this issue that the indicating pyrometer on the control board of the Submerged Combustion recarbonation process, at the Quincy, Ill., softening plant, carries the name "Wheelco."

Bailey Meter Opens Detroit Office

● Bailey Meter Co., Cleveland, Ohio, announces the opening of a Detroit Branch Office. Although the company has been previously represented in Detroit by resident engineers the increased demand for sales and engineering service has necessitated the opening of a formal office.

This office, which is located in Room 226 Curtis Building, is under the management of Mr. N. M. Barnett, who is ably assisted by Messrs. R. F. Hanson and R. T. Cowan.

WESTON

GASKET AND FORM

The Perfected Method for Making SEWER PIPE JOINTS OF CEMENT

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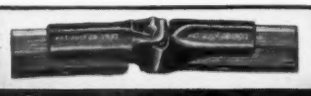

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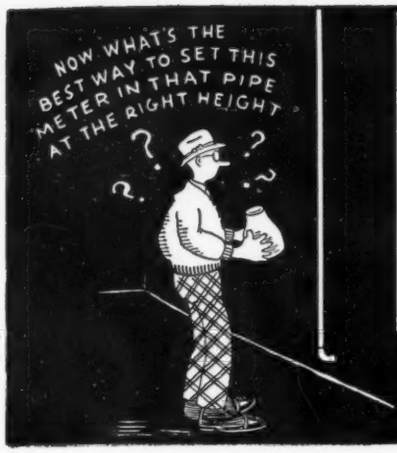

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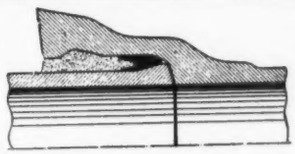

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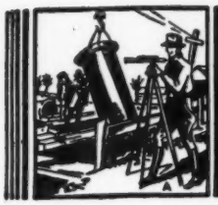

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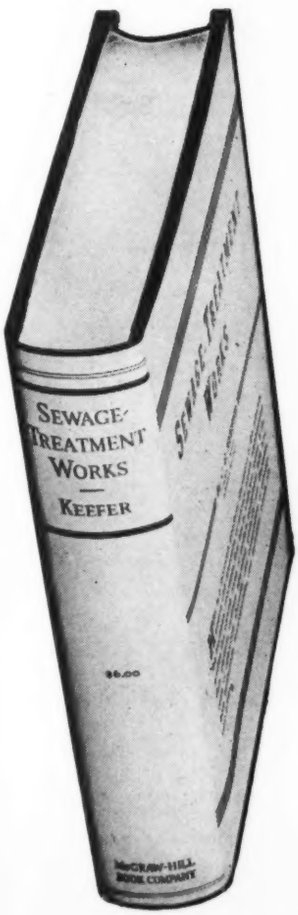

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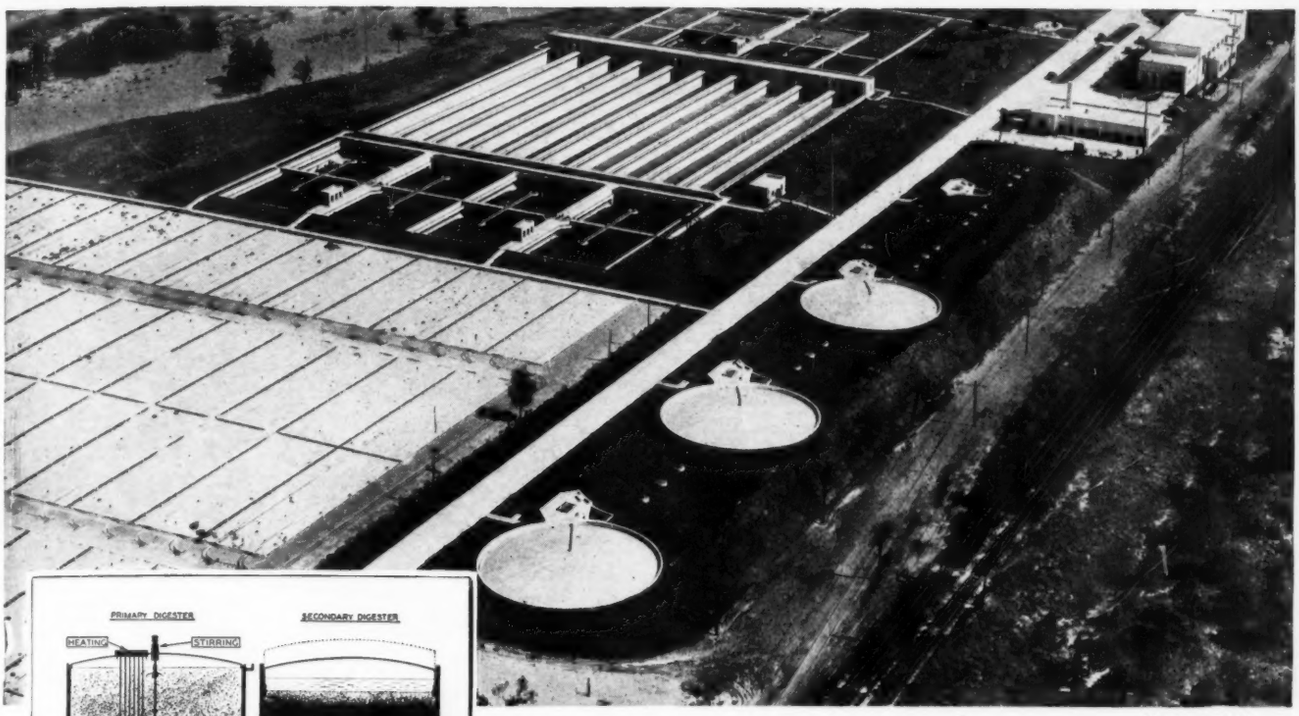

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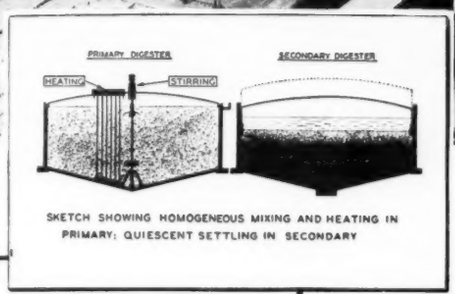

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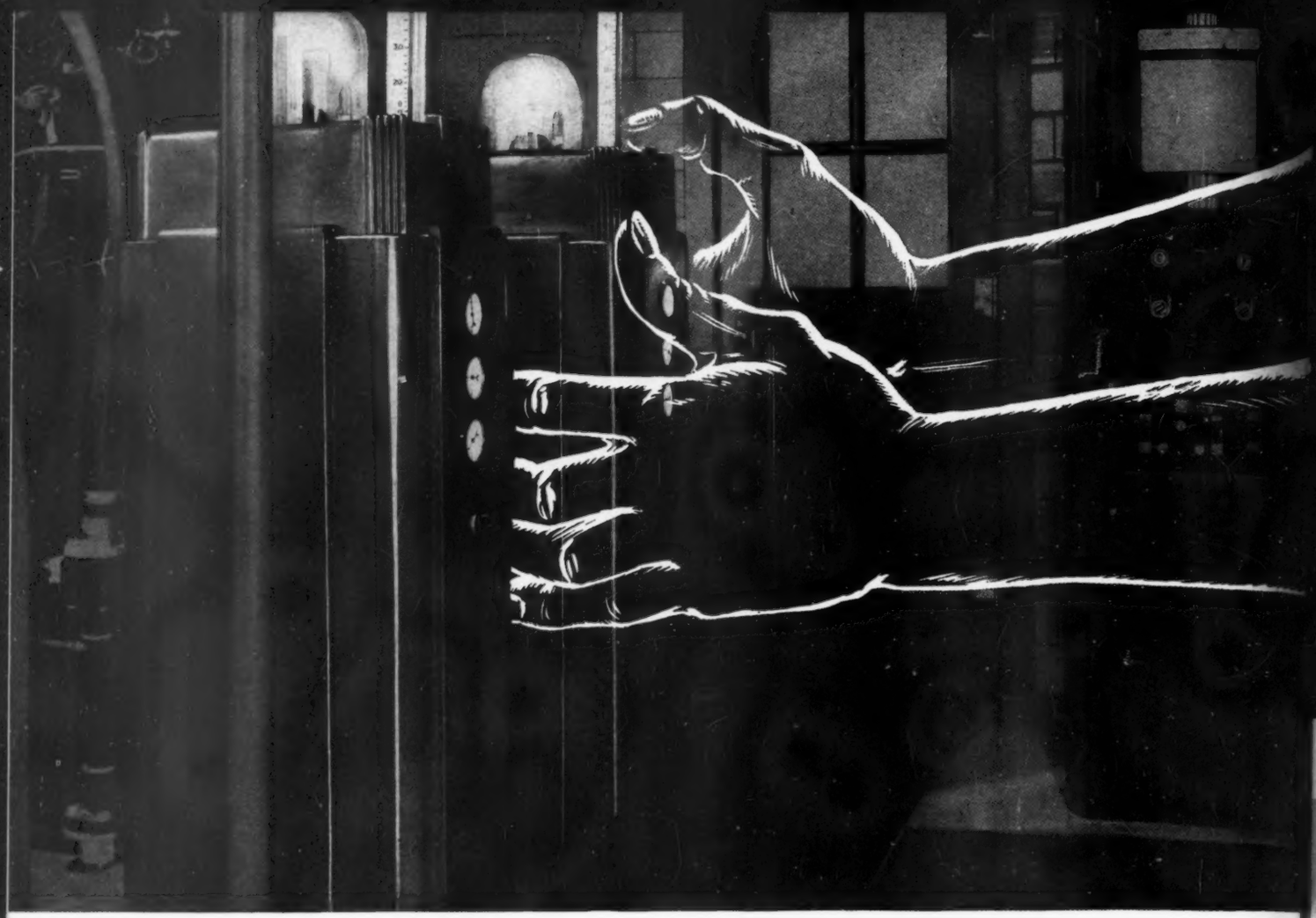

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